REPORT

ON THE

Activities of the Scientific Research Committee, Uttar Pradesh and Abstracts of Works

ON THE

RESEARCH PROJECTS SPONSORED

BY IT

1954—1957

ALLAHABAD:
SUPERINTENDENT, PRINTING AND STATIONERY, UTTAR PRADESH, INDIA
1958

CONTENTS

THE REPORT ON THE ACTIVITIES OF THE SCIENTIFIC RESEARCH COMMITTEE, UTTAR PRADESH AND ABSTRACTS OF WORKS ON THE RESEARCH PROJECTS SPONSORED BY IT DURING 1954-57

1. The Scientific Research Committee was constituted in the year 1947 by Government of Uttar Pradesh for promotion and encouragement of scientific research in the Universites and other institutions located in this State.

2. The report on the activities of the Committee, including the summaries and abstracts on the research projects sponsored by it during 1947-54, has already been published. The present report covers the period 1954-57.

3. The Committee was reconstituted under G. O. no. A-(2)/10068/XV—600(7)-1957, dated November 4, 1954, for the third time for a term of three years with effect from August 16, 1954, with the following personnel :

(1) *Chairman*—Dr. N. K. Sathi Civil Lines, Agra.

(2) *Five representatives of Universities situated within this State.*—

(1) Allahabad University—Dr. Satya Prakash.

(2) Lucknow University—Dr. S. N. Das Gupta.

(3) Banaras Hindu University—Dr. Yajnavalkya Bharadwaja.

(4) Muslim University—Dr. P. S. Gill.

(5) Agra University—Dr. V. Puri.

Other Members

(1) Principal, Harcourt Butler Technological Institute, Kanpur.

(2) Principal, Agricultural College, Kanpur.

(3) Dr. B. Mukerji, Director, Central Drug Research Institute, Lucknow.

(4) Dr. Sadgopal, Forest Research Institute, Dehra Dun.

(5) Sri R. L. Powell, Director, British India Corporation, Kanpur.

(6) Dr. Gopal Tripathi, Banaras Hindu University.

(7) Dr. A. R. Kidwai, Muslim University, Aligarh.

(8) Dr. S. R. Narayan Rao, Lucknow University.

Dr. Satya Prakash continued to work as the Secretary of the Committee.

Sri R. L. Powell having resigned, Sri Sita Ram Jaipura of the Swadeshi Cotton Mills, Kanpur, was nominated by Government in his place on the Committee.

4. The inaugural meeting of the reconstituted Committee was held on February 1, 1955, at the Council House, Lucknow. On the invitation of Government, the industrialists of this State such as Sri Padampat Singhania, Sri Ramratan Gupta, Sri Gujarmal Modi, Sri Banwari Lal Jaipuria and Sri Hari Shankar Bagla, also attended this meeting and participated in the general discussions. The Chief Minister in his inaugural address remarked that the Committee had two objectives: (i) promotion of research in fundamental sciences and, (ii) promotion of research in applied sciences. He made observations on the progress of the Committee during the past years. The resources of the State being meagre, he invited the cooperation of the industrialists in the promotion of fundamental and applied sciences in the State. He said, it has been realized in the West that the applied research progresses hand in hand along with the fundamental research. The Chief Minister stressed on the work on applied side, and he invited the co-operation of the Universities of this State in this connection. Further, he very much wished that there should have been more industries in this State. The Chief Minister said that he was aware of the fact that the industries would need many types of help but they could rest assured that they would have all necessary facilities for this purpose from the State, Chief Minister appealed to the industrialists to co-operate with the Committee in promoting research on industrial problems.

5. In the discussion that followed Sri Gujarmal Modi, Sri Padampat Singhania, Sri Ramratan Gupta, Sri Bagla and other members suggested ways and means by which the Committee would secure closer co-operation with industries.

GRANTS FOR RESEARCH

6. During the period under review the following research grants were awarded by Government on the recommendations of the Scientific Research Committee :

Year	U. G. C. Grants for the work done in the Universities	S. R. C. Grants for the work done in the Non-University institutions
1954-55 ...	1,48,800	31,200
1955-56	1,48,300	40,000
1956-57	2,98,300	60,000

The following figures will indicate the grants received by the Universities and other principal research centres of the State.

Universities and Institutions	1954-55	1955-56	1956-57
Allahabad University ...	27,430	22,355	54,930
Lucknow University ...	40,120	31,570	54,950
Banaras Hindu University ...	24,080	42,760	52,880
Muslim University, Aligarh ...	10,850	17,010	17,140
Agra University and Colleges ...	26,600	31,220	31,540
Harcourt Butler Technological Institute, Kanpur.	...	12,775	21,274
Forest Research Institute, Dehra Dun.	14,220	10,750	11,374
Central Drug Research Institute, Lucknow.	...	2,300	4,720
Indian Institute of Sugar Technology, Kanpur.	2,300	...	...
Birbal Sahni Institute of Palaeobotany, Lucknow.	...	...	2,300
Department of Plant Protection	...	2,300	6,420
Director of Agriculture, Lucknow	2,370	1,025	...

7. *List of the research projects sponsored by the Committee during the* 1955-57—The projects marked with asterisks are those for which only the contingent grants of Rs. 500 a year for two years were granted. The rest are the full unit projects which were worked out by the researchers with the help of a Research Assistant appointed on a salary of Rs. 150 per month in the first year and Rs. 160 in the second. The total grant for such units for two years was Rs. 4,720, inclusive of a contingency grant of Rs. 1,000.

The U. G. C. projects refer to such projects as on the recommendations of this Committee and the University Grants Committee are worked out in the Universities or Colleges, affiliated with them and situated within the State and they receive their grants directly from Government. The S.R.C. projects refer to such projects as were carried out in the Non-University institutions in the State and the grants for which were directly disbursed by the Committee.

U.G.C. PROJECTS

PHYSICS

Serial no.	Name of researcher	Title of the subject
	ALLAHARAD UNIVERSITY	
	1955	
1	Dr. K. Majumdar ...	Investigation in optical instruments and spectroscopy of molecules.
	1957	
1	Sri Devendra Sharma ...	Spectroscopic investigation of intermetallic molecules.
2	Sri Krishnaji ...	Study of the magnetic resonance and absorption of substance in the microwave region.
*3	Dr. Yatendra Pal Varshni.	Investigation in molecular structure and spectra.
	LUCKNOW UNIVERSITY	
	1955	
*1	Dr. P. G. Deo ...	Studies of etching of metal and alloy (Babbut and Bronze) crystals under cathodic sputtering.
	BANARAS HINDU UNIVERSITY	
	1955	
1	Dr. S. R. Khastagir ...	Study of ionospheric movement by radio fading method.
	1956	
1	Dr. Nand Lal Singh ..	Emission spectra of polyatomic molecules.
	MUSLIM UNIVERSITY ALIGARH	
	1955	
1	Dr. P. S. Gill ...	Study of heavy mesons using nuclear emulsions.

Serial no.	Name of researcher	Title of the subject
	1956	
1	Dr. P. Venkateswarlu ...	The molecular spectra of halogens in the ultra-violet region.

AGRA UNIVERSITY AND COLLEGES

	1956	
1	Dr. D. D. Pant ...	Fluorescence spectra of uranyl salts.
	1957	
1	Dr. A. Mookerji ...	To study the paramagnetic behaviour of tetra co-ordinated cobalt salts.

CHEMISTRY

ALLAHABAD UNIVERSITY

	1955	
*1	Dr. Krishna Bahadur ...	Photosynthesis of amino-acids, using paraformaldehyde and potassium nitrate.
*2	Dr. Satya Prakash ..	On micro-colloidal technique.
	1956	
1	Dr. S. Ghosh ...	Studies in periodic precipitation.
2	Dr. Satya Prakash ...	The study of chelate compounds with special reference to acetyl acetonates.
3	Dr. N. R. Dhar ...	Researches on phosphates, their importance in nitrogen fixation and amino acid synthesis.
*4	Dr. P. N Saxena ...	Kinetics of sol-gel transformation
	1957	
1	Dr. Arun K. Dey ...	Studies in anionic co-ordination compounds involving carboxylic acid group ligands.

Serial no.	Name of researcher	Title of the subject
2	Dr. I. K. Taimni ...	Systematic investigation of the method of detecting and estimating all the well known acids in different combinations.
3	Dr. Bal Krishna ...	Dipole moment, dielectric constant and interaction of solute and solvent.
4	Sri C. O. Dass ...	A study of the utilisation of two different concentrate mixtures by dairy cows.
	LUCKNOW UNIVERSITY	
	1955	
1	Dr. A. C. Chatterji ...	Investigation on nucleation phenomenon.
2	Dr. K. C. Joshi ...	Studies in antimetabolites.
3	V. S. Misra ...	Chemotherapy in tuberculosis.
4	Dr. M. C. Rastogi ...	Birth and growth of sol particles.
5	Dr. A. N. Bose ...	The physical properties of solubilised solution of alcohols in aqueous soap solutions.
	1957	
1	Dr. A. B. Sen ...	Chemotherapy of amoebiasis.
2	Dr. R. C. Mehrotra ...	Organic compounds of transition elements.
3	Dr. A. C. Chatterji ..	(i) Polarographic investigation of known solid complexes of the transitional metallic ions in the modern sense.
		(ii) Potentiometric and polarographic study on complexions formed between the phosphates, the unidentate carboxylations and transitional metallic ions.

Serial no.	Name of researcher	Title of the subject
4	Dr. Gauri Shanker Misra	Some addition reaction of azodicarbonic diethyl (ROOOM-M-OOOR).
*5	Sri Parambans Tewari ...	Charge and stability of colloids; effect of non-electrolytes
*6	Sri Soma Kumar ...	Separation of fatty acids by paper electrolysis.
7	Dr. P. S. Krishnan ...	Utilization of molasses for production of organic acids.
	Banaras Hindu University Varanasi.	
	1955	
1	Dr. S. S. Joshi ...	Comparative studies of electrically and thermally sustained reactions, specially in solid media.
	1956	
1	Dr. Sarju Prasad ...	Studies on the extraction of titanium compounds from ilmenite.
2	Dr. P. N. Bhargava ...	Chemical examination of *alangium lamarcii* (for use in medicine).
3	Dr. Bawa Kartar Singh...	Studies on the refractive dispersion of derivatives of terpenes and their co-relation with their rotary dispersion.
	1957	
1	Prof. S. S. Joshi ...	Study of the light effect on electrical discharge in infra red.
	Muslim University, Aligarh	
	1956	
1	Dr. W. U. Malik ...	Studies on the permeability of metallic ferro- and ferri-cyanide membranes.
2	Dr. Intisar Husain ...	Gluconic acid fermentation.

Sorial no.	Name of researcher	Title of the subject
	1957	
1	Dr. M. U. Malik ...	Sol-gel-transformation.
	AGRA UNIVERSITY AND AFFILIATED COLLEGES	
	1955	
*1	Dr. M. M. Bokadia ...	To study the acylation and alkylation of ketones.
*2	Dr. R. C. Rai ...	Study of Werner's compounds formed by the molecules of different strong and weak bases with blue perchromic acid.
*3	Dr. O. P. Bansal	Humification of clays and soils.
*4	Dr. K. K. Baslas ...	Studies on the constitutents of essential oils from Indian plants and synthesis of terpenes and sesquiterpenes.
*5	Dr. K. P. Jain ...	Studies on the reaction between g latine and potassium di-chromate with a view to find conditions for the production of an adhesive insoluble in polar and non-polar solvents.
	1956	
1	Dr. A. K. Bhattacharya...	Volumetric estimation of iron in natural ores by KMnO in presence of HCl.
2	Dr O. N. Perti ...	Study of substituent groups on the optical activity of derivatives of Reychler's acid.
*3	Dr. Nand Kishore ...	Studies in the oxidation of metallic hydroxides as chromium hydroxide.
*4	Dr. M. M. Bokadia ...	To study acylation and allylation of ketones.

Serial no.	Name of researcher	Title of the subject
*5	Dr. H. G. Garg	To evolve new methods for the preparation of ketones and to study their reactions under different conditions.
*6	Dr. S. P. Srivastava ...	Kinetics of oxidation reaction by persulphate ion.
*7	Dr. N. P. Agarwal ...	Electrode kinetics.
	1957	
1	Dr. S. S. Joshi ...	Chemical examination of some medicinal plants.
2	Dr. R. N. Singh ...	Cyclisation in condensation reactions.
3	Dr. P. I. Ittyerah ...	Synthesis of certain hetero-cyclic ketones and their derivatives.

MATHEMATICS

ALLAHABAD UNIVERSITY

	1957	
1	Dr. B. N. Prasad ...	Divergent series.
2	Dr. Gorakh Prasad ...	Equations of viscous motion.

LUCKNOW UNIVERSITY

	1956	
1	Dr. S. C. Gurya ..	Analysis of time series with special reference to meteorological observations.
2	Dr. Ram Ballabh ..	Superposition of flows.
	1957	
1	Dr. R. P. Agarwal ...	Special function and transforms in the theory of complex variables.

Serial no.	Name of researcher		Title of the subject
	BANARAS HINDU UNIVERSITY		
	1956		
1	Dr. V. Narlikar	...	The problem of motion in general relativity and the unified theories.
2	Dr. Brij Mohan	...	Self reciprocal functions.
	MUSLIM UNIVERSITY, ALIGARH		
	1956		
1	Dr. S. M. Shah	...	Finite and infinite matrices and their eigen-values.
2	Dr. A. Siddiqui	...	Generalised quasi-analytic classes of functions.
	1957		
1	Dr. U. N. Singh	...	Researches in harmonic analysis generalised transforms, trigonometrical series and integrals, abstract spaces, closure problem, etc.
	BOTANY		
	ALLAHABAD UNIVERSITY		
	1955		
*1	Dr. S. P. Naithani	...	Cytogenetical and breeding studies in *brinjals* (*Solanum melongena*. L.)
*2	Dr. A. K. Mitra	...	Study of soil algae in relation to the fertility of cultivated soils specially rice fields.

Serial no.	Name of researcher	Title of the subject
	1957	
1	Dr. S. Ranjan ...	Nitrogen metabolism in higher plants.
2	Dr. R. N. Tandon ..	Leaf spot diseases of some garden and fruit trees.
3	Dr. R. K. Saxena ..	Studies in some lower fungi.
*4	Dr. R. C. Lacy ...	Survey of soil *fungi* in Allahabad.
	LUCKNOW UNIVERSITY	
	1956	
1	Dr. S. N. Das Gupta ...	Studies in physiologic specialisation in *Smuts*.
2	Dr. S. K. Pandey ...	Studies in Himalayan liverworts.
	1957	
1	Dr. S. C. Agrawala ...	Study of iron metabolism in higher plants with special reference to enzyme systems having iron containing prosthetic group.
2	Dr. J. N. Rao ...	Microbiology of *usar* soil with special reference to fungal microflora.
3	Dr. B. S. Trivedi ...	Monographic study of Indian Dryopteridaceae. Thelypteridaceae Sensu Holtum.
	BANARAS HINDU UNIVERSITY, VARANASI	
	1956	
1	Dr. C. S. Prakash ...	Isolation and maintainance of pure culture and algae.
2	Dr Ram Nagina Singh ..	Refractrometery of living cell-algae.
	1957	
1	Dr. Jogendra Nath Misra	Studies on fresh water rhodiophyceae (red algae) of U. P.
2	Dr. R. Misra ...	Ecological flora of Banaras District.

Serial no.	Name of researcher	Title of the subject
	MUSLIM UNIVERSITY, ALIGARH	
	1957	
1	Dr. Reayat Khan ...	Study of the *in vitro* culture of the embryo of wheat.
	AGRA UNIVERSITY (AFFILIATED COLLEGES)	
	1955	
1	Dr. I. M. Rao ...	Physiological studies in salt tolerance of rabi crop plants.
2	Dr. Bahadur Singh ..	Structure and development of seeds in Euphorbiaceae and allied families.
*3	Dr. N. K. Anant Rao ...	Fertilizer studies on wheat, use of leaf analysis and tissue tests in the diagonisis of mineral requirements of wheat.
* 4	Dr. S. Sinha ...	Studies on forest flora of Agra and Mathura districts adjoining Rajasthan.
	1956	
1	Dr. V. Puri	Monographic studies of *Acacia Arabica*.
2	Dr. S. Sinha ..	Stem gall disease of coriander.
*3	Dr. Satish Chandra ...	Studies in pectic enzymes secreted by fungi causing rot in crops.
	1957	
*1	Sri K. C. Basu Chaudhry	Production of the fungi static substance by certain soil micro-organism active against some soil borne plants pathogens.
*2	Dr. M. L. Banerji ...	Study of vegetation on saxes, shingles and Rubnels in Koshi catchment.

ZOOLOGY

Serial no.	Name of researcher	Title of the subject
	ALLAHABAD UNIVERSITY	
	1955	
1	Dr. Dharam Narayan ...	Studies on the life history, etc., of certain larvicidal fishes.
*2	Dr. P. N. Srivastava ...	Biology of the fishes of Hilsa.
	1956	
1	Dr. S. K. Dutta ...	Studies on lateral lines and head canal sense organs in fishes.
	1957	
1	Dr. M. D. Lal Srivastava	The structure and behaviour of chromosomes of certain Indian archinids and crustaceans.
	LUCKNOW UNIVERSITY	
	1955	
1	Dr. M. B. Lal ...	Studies on the anti-coagulant from the leech rudinaria.
*2	Dr. B. S. Tewari ...	Paleontological investigation of the tertiary rocks of Western Kutch.
	1956	
1	Dr. S. M. Dass ...	A fundamental investigation on the life histories of the fishes of Uttar Pradesh.
	BANARAS HINDU UNIVERSITY, VARANASI	
	1956	
1	S. N. Mehrotra	The annual history of the interstitial cells in the gonads of reptiles.

Serial no.	Name of researcher	Tittle of the subject
	MUSLIM UNIVERSITY, ALIGARH	
	1955	
1	Dr. P. N. Ganju ...	Petrological study in Indian coals.
	AGRA UNIVERSITY AND AFFLIATED COLLEGES	
	1955	
*1	Dr. R. P. Saxena ...	Development of a technique for dry preservation of animals and insects for museums.
*2	Dr. H. S. Choudhary ...	The morpbological and biological studies of barbustor (Mahoseer) and other food fishes of lake.
	1957	
1	Dr. K. S. Bhargava ...	A study of virus diseases of economic plants of U. P.
2	Dr. Beni Charan Mahendra	The development of the Weberian ossicles in Indian teleosts.
	GEOLOGY	
	LUCKNOW UNIVERSITY	
	1957	
*1	Dr. K. P. Vimal ...	Study of fossil algae from India.
*2	Dr. S. B. Bhatia ..	Paleontology and stratigraphy of the tertiary deposits of Surat Branch area, Western India.
	BANARAS HINDU UNIVERSITY	
	1956	
1	Dr. R S. Mithal ...	Investigations and geological study of Bijapur sillmanite occurrence (district Mirzapur, U. P.)

Serial no.	Name of researcher	Title of the subject
*2	Dr. I. C. Pandey ...	The structure of the Naini Tal Himalayas, U. P.
*3	R. C. Sinha	Geochemical investigation of the main types of soils of Eastern U. P.
	1957	
*1	Dr. Maharaj Narayan Mehrotra.	Geology and petrology of the Latehar area district Palamau.
2	Dr. Raj Nath ...	A study of soil mineralogy of the Mirzapur District with regard to land utilisation.

AGRICULTURE

Allahabad University

	1956	
1	Dr. J. C. Edwards, Agriculture Institute, Naini.	Mastitis in milking herd of cows at the Allahabad Agriculture Institute.

Banaras Hindu University, Varanasi

	1955	
1	Dr. S. Kashinathan ...	Nature of the activity of the growth factors of fungus *Gossypii nematospora*.
	1956	
1	Dr. K. D. Baweja ...	Studies of soil fauna, particularly insects, in relation to climate and plants, growth and their control.
	1957	
1	Dr. Sant Singh ...	Study of the organic matter of some soils of U. P.
2	Dr. Q. S. Choudhari ...	Weed control through treatment with hormonal herbicides.

Serial no.	Name of researcher	Title of the subject
	AGRA UNIVERSITY AND AFFILIATED COLLEGES	
	1955	
1	Sri B. N. Prasad Ghildyal.	Studies on the nature of process of nitrification in the alluvial soils of Uttar Pradesh.
2	Dr. T. R. Mehta ...	Artificial production of polyploids in vegetables.
3	Dr. J. M. Sharma ...	Rotational studies in wheat.
	1956	
1	Dr. J. G. Srikhande ...	Influence of insecticides on soil unicloflora.
	MEDICINE	
	1955	
*1	Dr. R. M. L. Mehrotra, K. G. M. College.	Investigation of factors concerned in the production of appendicites.
	1956	
1	Dr. T. N. Chawla ...	Incidence of dental caries of gingenal status in Lucknow school going children.
2	Prof. S. S. Misra ...	Investigation of tuberculus meningitis with special reference to detection of tubercle bacilli in the cerebro-spinal fluids.
	1957	
1	Dr. N. P. Gupta, Department of Pathology and Bacteriology.	Investigation into the natural history of herpes virus among Indians.
	BANARAS HINDU UNIVERSITY, VARANASI	
	1955	
*1	Dr. N. K. Basu ...	Investigation of Indian medicinal plants on *Convolvulus pluricaulis*

Serial no.	Name of researcher	itle of the subject
*2	Dr. S. Prasad ...	Work relating to cultivation of Rauwilfia serpentina.
	1956	
1	Dr. D. D. Mazumdar ...	(i) Indian medicinal plants with *Amia somniferadinal* (Ashwagandha) (ii) Chemical and physiological characterisation of the alkaloidal constituents.

APPLIED

Banaras Hindu University, Varanasi

	1955	
1	Dr. S. S. Banerji ...	Design and development of electronic instruments.
	1956	
1	Dr. Gopal Tripathi ...	Chlorination of tar asphalt and bitumen for lubricants.
	1957	
1	Dr. S. P. Pathak ...	Study of fish oil.

MISCELLANEOUS

Lucknow University

	1957	
1	Prof. Kali Prasad ...	Schemes of research in students' attitude and values (experimental social psychology).
2	Dr. G. S. Varma ..	Studies of micro and macro nutrition on plant viruses with special reference to cruciferous plants.
*3	Dr. B. S. Trivedi ...	Cruciferous plants, monographic study of Indian Dryopteridaceae, Thelypteridaceae sensu holtum.

Serial no.	Name of researcher	Title of the subject
	BANARAS HINDU UNIVERSITY, VARANASI	
	1956	
1	Dr. D. K. Chakravarti ...	Investigation of the granitic intrusions of U. P. and adjoining states with special references to the metalliferous veins and deposits associated with them.

S. R. C. PROJECTS

INDUSTRIAL CHEMISTRY

	INDIAN INSTITUTE OF SUGAR TECHNOLOGY, KANPUR	
	1954-55	
1	Dr. S. Mukerjee ...	Chemical investigations on the structure of plant gums.
*2	Dr. K. S. G. Doss ...	Electrode processes
	GOVERNMENT CENTRAL TEXTILE INSTITUTE, KANPUR	
	1954-55	
*1	Sri P S. Mathur ...	Studies in the synthesis and dyeing properties of mixed fluoresceins and eosins derived therefrom.
	HARCOURT BUTLER TECHNOLOGICAL INSTITUTE, KANPUR	
	1954-55	
1	Dr. D. R. Dhingra ...	Sulphonated organic materials and their use in leather and other industries.
2	Sri Om Prakash ...	Improvement of drying properties of linseed oil by chemical changes including isomerisation.
3	Sri G. N. Gupta ...	The study of the development of the constituents of the essential oils at different stages of growth of the plant grown at Kanpur.

Serial no.	Name of researcher	Title of the subject
4	Dr. D. R. Dhingra ...	Rose oil scheme.
5	Dr. M. S. Bhatnagar ..	Chromatographic estimation and separation of the constituents present in *Palmorosa eucalyptus* and lemon grass oils.
	1955-56	
1	Dr. B. K. Jha ...	Production of food yeast from industrial waste such as distillery spent wash, deteriorated molasses and residual sludge of fermentation.
2	Dr. A. C. Gupta ...	Study of the urea formaldehyde and alkyl resins and alkyl urea resins with their utilisation for surface coating, etc.
3	Sri G. N. Gupta ...	A study of the efficiency of different types of stills used for the distillation of essential oils.
*4	Sri S. N. Kapoor ...	Studies on the preparation of chemical gold thread, i. e., *Kalabattu*.
5	Sri W. R. Damle ...	Utilisation of slaughter house waste for preparation of pharmaceutical products.
6	Sri G. N. Gupta ...	The study of the development of the constituents of the essential oils at different stages of growth of the plant grown at Kanpur.
	1956-57	
1	Dr. M S. Bhatnagar ...	A study of the effect of various fillers on the physical and mechanical properties of moulding powders.
2	Dr. D. R. Dhingra ...	Synthetic rubber (preparation of a comprehensive report on the prospects of rubber industry in this country with economic details.)
3	Dr. B. K. Jha and Sri W. R. Damle.	To work on the preparation of butanediols and other related fermentation products.

Serial no	Name of researcher	Title of the subject
	FOREST RESEARCH INSTITUTE, DEHRA DUN	
	1954-56	
1	Dr. Sadgopal ...	Chemical examination of the essential oil of vetiver and methods of estimating the important constituents from the roots of *Vetiveria Zianioides* (Linn.) Nash.
2	Dr. Sadgopal ...	Chemical examination of the essential oil of valerian from valeria species.
3	Dr. S. V. Puntambekar ...	Study of new sources of drying oils from seeds of the indigenous plants of the Euphorbiaceae family.
4	Dr. P. Ram Chandra ...	Preparation of chlorophyllins from leafy sources of U. P. and testing them for their deodorant activity *in vitro*.
4	Dr. Sadgopal ...	Chemical studies on the fatty oils from the seeds of— (i) *Buxus semiperverin*, (ii) *Bischofia javanica*, (iii) *Bolvisperum montona*, (iv) *Aleurites tribola* (Euphorbiaceae family).
	DIRECTOR OF AGRICULTURE, LUCKNOW	
	1954-56	
1	Dr. S. B. Singh ...	Economic evaluation of the over-all benefits of improved technological practices by carrying them out in farmer's holdings.

Serial no.	Name of researcher	Title of the subject
	CENTRAL DRUG RESEARCH INSTITUTE, LUCKNOW	
	1954-57	
1	Dr. B. Mukerji ...	Colourisation of vegetable oil products.
	1956-57	
1	Dr. B. Mukerji ...	Chemical and pharmacological investigation of the following drugs— (1) *Argyreia speciosa* sweet (Syn. Lettsoxia nervosa roxb.) (2) *Pergularia extensa*, N. E. Br. (*Syn. daemia extensa*, R. Br.)
	PLANT PROTECTION	
	DEPARTMENT OF PLANT PROTECTION, KANPUR	
	1955—57	
	Dr. A. S. Srivastava ...	Studies on chemical control of certain important pests and nematodes attacking crops with particular reference to physiological and biochemical changes induced by the application of insecticides.
	SYNTHETIC RUBBER	
	LUCKNOW UNIVERSITY	
	1956-57	
1§	Dr. Gauri Shanker Mishra, Chemistry Department.	Polymerisation of monomers to synthetic elastomers.
2§	Dr. P. S Krishnan, Chemistry Department.	Production of 2:3 butanediols and (2:3) butylene glycol by molasse fermentation.

§The work could not start.

Serial no.	Name of researcher	Title of the subject
	ALLAHABAD UNIVERSITY	
	1956-57	
1	Dr. Krishna Bahadur, Chemistry Department.	Preparation of butanediols and other related fermentation products utilized in the synthetic rubber industry.
	FORESTRY	
	FOREST RESEARCH INSTITUTE, DEHRA DUN	
	1954-55	
1	Sri C. R. Rangnatham ...	The studies on the methods of treatment of *timber* against attack by marine organisms.
2	Dr. A. Purshottam ...	Development of suitable chemical treatment of protection of *bamboo* against decay by fungi, insects and against fire.
	1955-56	
1.	Dr. B. K. Bakashi ...	Wilt and other root diseases of Shisham; biochemical and physiological studies on the pathogens with a view to evolve control measures.
2	Dr. G. S. Pur ...	Physiological and ecological relation of Soria robusta with other forest species occurring in different types of habitats in U. P.

NOTE—Those marked with * (asterisks) indicate contingency grants only.

MEETINGS

8. During these years, the Committee held the following meetings

1954-55

1. At the Roorkee Engineering University, Roorkee, on April 19 and 20, 1954.

2. At the Lucknow University, Lucknow, on August 12 and 13, 1954.

3. At the Council House, Lucknow, on February 1 and 2, 1955.

1955-56

1. At the Harcourt Butler Technological Institute, Kanpur, on May 6 and 7. 1955.

2. At the Central Drug Research Institute, Lucknow, on August 12 and 13, 1955.

3. At the Forest Research Institute, Dehra Dun, on October 8 and 9, 1955.

4. At the Allahabad University, Allahabad, on March 4 and 5, 1956.

1956-57

1. At the Social Sciences Institute, Agra University Buildings, Agra, on August 4 and 5, 1956.

2. At the Allahabad University, Allahabad, on October 27, 1956.

3. At the Muslim University, Aligarh, on February 4, 1957.

1957-58

1. At the Secretariat Building, Naini Tal, on June 8 and 9, 1957.

VISITS TO INSTITUTIONS

9. On behalf of the Committee, the members visited the following institutions of this State. They explained to them the objectives of the Committee and sought their co-operation in this connection. They also discussed research problems and acquainted themselves with the work which is progressing in this State at these institutions.

1. Allahabad University.
2. Aligarh University.
3. B. R. College, Agra.
4. St. John's College, Agra.
5. Dayal Bagh Engineering College, Agra.
6. D. S. B. Government College, Naini Tal.
7. Harcourt Butler Technological Institute, Kanpur.
8. Central Drug Research Institute, Lucknow.
9. Railway Research Centre, Lucknow.
10. National Botanical Gardens, Lucknow.
11. Birbal Sahni Institute of Palaeobotany, Lucknow.
12. Forest Research Institute, Dehra Dun.

SUB-COMMITTEES FOR SCRUTINY

10. For the scrutiny of applications for research grants the Committee from amongst its own members had formed three Sub-Committees, the recommendations of which were considered at a later stage by the Scientific Research Committee.

(1) *Sub-Committee for Physical Sciences*—

(i) Dr. N. K. Sethi.

(ii) Dr. P. S. Gill.

(iii) Dr. A. R. Kidwai.

(iv) Dr. Satya Prakash.

(2) *Sub-Committee for Biological Sciences*—

(i) Dr. S. N. Das Gupta.

(ii) Dr. Yajnavalkya Bharadwaja.

(iii) Dr. S. R. Narayana Rao.

(iv) Dr. V. Puri.

(v) Principal, Government Agriculture College, Kanpur.

(vi) Dr. B. Mukerji.

(3) *Sub-Committee for Applied and Industrial Sciences*—

(i) Dr. Gopal Tripathi.

(ii) Dr. Sadgopal.

(iii) Principal, Harcourt Butler Technological Institute, Kanpur.

The Committee is thankful to the eminent scientists of this country who helped the Committee in the scrutiny of the periodical reports of the work done on the various projects. The Committee has in its possession a panel of names of referees appointed at its meetings for the scrutiny of these reports. The relevant parts of the observations made by the referees on these reports are sent to the researchers for necessary action.

MEDICINAL PLANTS FOR CULTIVATION

11. The Committee entrusted to Dr. B. Mukerji, Director, Central Drug Research Institute, Lucknow, the work of drawing a list of medicinal plants found wild in Uttar Pradesh and which need improved cultivation in this State, and which could be utilized for medicinal purposes on commercial scale. The list prepared under the direction of Dr. B. Mukerji is of importance and is reproduced below ;

List of Medicinal Plants growing wild in India which require to be cultivated and can be cultivated in Uttar Pradesh

Serial no.	Name of species	Where it can be cultivated
1.	Aconitum chasmanthum Stapf. *ex* Holmes.	U. P. Himalayas at 6,000 to 10,000 feet.
2.	A. heterophyllum Wall ...	As above.
3.	A. brevifollia Wall ...	U. P. in inner Himalayas at 7,000 to 10,000 feet.
4.	Atropa acuminata Royle *ex* Lindley.	U. P. Himalayas at 6,000 to 10,000 feet.
5.	Citrullus colocynthis (Linn.) Schrad.	Plains of U. P.
6.	Colchicum luteum Baker ...	U. P. in temperate Himalayas at 4,000 to 9,000 feet.
7.	Datura innoxia Mill ...	U. P. Hills.
8.	Ephedra gerardiana (Wall) Stapf.	Inner Himalayas of U. P. at 8,000 to 10,000 feet in dry places.
9.	E. nebrodensia (Tineo) Stapf	As above.
10.	Gentiana kurroo Royle ...	U. P. Himalayas at 5,000 to 10,000 feet.
11.	Hyoscyamus niger Linn. ...	Ditto.
12.	Nardostachys jatamansi D. C .	U. P. Himalayas at 6,000 to 10,000 feet.
13.	Picrorhiza kurroo Royle *ex* ...	U. P. Himalayas at 7,000 to 10,000 feet.
14.	Podophyllum hexandrum Royle *ex* Benth.	U. P. Himalayas at 6,000 to 10,000 feet.
15.	Polygalla chinensis linn. ...	Plains up to 5,000 feet.
16.	Rauwolfia serpentina Benth *ex* Kurz.	Up to 3,000 feet.
17.	Rheum emodi wall ...	U. P. Himalayas at 5,000 to 8,000 feet.
18.	Swertia chirata Buch.-Ham. ...	U. P. Himalayas at 3,000 to 8,000 feet.
19.	Valeriana officinalis Linn. ...	U. P. Himalayas at 5,000 to 8,000 feet.

LIST OF MEDICINAL PLANTS OF IMPORTANCE FOUND WILD IN UTTAR PRADESH

1. Acacia arabica (Lam.) Wild.
2. Aconitum heterophyllum Wall.
3. A. deinorrhizum Stapf.
4. A. falconeri Stapf. (For items 2, 3 and 4. Natural sources should be supplemented by cultivation in the hills above 7,000 ft. high).
5. Acorus calamus Linn.
6. Aegle marmelos (Linn.) Corr.
7. Angelica glauca Edgw.
8. Adhatoda vasica Nees.
9. Aristolochia indica Linn.
10. Artemisia brevifolia Wall. (Requires cultivation in inner Himalayas.)
11. Asparagus racemosus Wil'd.
12. Azadirachta indica A. Juss.
13. Bacopa moniera Wettst (Herpestis monniera).
14. Berberis aristata DC. and other species.
15. Boerhaavia repens Linn.
16. Cannabis sativa Linn.
17. Cassia fistula Linn.
18. Chlorophytum arundinaceum Baker.
19. Cinnamomum tamala Fr. Nees.
20. Citrullus colocynthis Schrad.
21. Datura stramonium Linn. and other species.
22. Dryopteris sp.
23. Ephedra gerardiana (Wall) Stapf.
24. Gentiana kurroo Royle.
25. Hemidesmus indicus R. Br.
26. Holarrhena antidysenterica Wall.
27. Hydrocotyle asiatica Linn.
28. Ipomaea hederacea (Linn.) Jacq.
29. Mentha piperita Linn.
30. Nardostachys jatamansi DC.
31. Picrasma quassioides Benth.
32. Picrorhiza kurroo Royle *ex* Benth.
33. Piper longum Linn.
34. Podophyllum hexandrum Royle.
35. Polygala chinensis Linn. (Requires cultivation)
36. Psoralea corylifolia Linn.
37. Pterocarpus marsupium Roxb.

38. Rauwolfia serpentina Benth ex Kurz. (Requires cultivation).
39. Rheum emodi Wall.
40. R. webbianum Royle.
41. Swertia chirata Buch.-Ham.
42. Terminalia chebula Retz.
43. Urginea indica Kunth.
44. Valeriana wallichi DC.
45. Viola serpens Wall.
46. Withania somnifera Dunal.

PROBLEMS REFERRED TO THE COMMITTEE

12. *Degumming of Ramie*—Sri R. L. Powell of British Indida Corporation in one of his letters suggested a problem to be sponsored by the Committee on degumming of ramie fibre. In his letter, he indicated that ramie grows freely in this country and provides a strong fibre of high absorptive capacity and is used in the manufacture of ropes and fishing nets. It was suggested that if this fibre be degummed efficiently it could be spun and in combination with cotton and wool provide a suitable fabric. The Committee referred this problem to the Secretary, Indian Jute Mills Association Research Institute, Calcutta. The information submitted by this Institute showed that the problem of degumming of ramie has been studied by various other workers in details as indicated by the references given below. However, it would be of advantage to pursue a specific researc scheme if some industrialist subsidises it.

REFERENCES

Literature

1.	Degumming of ramie.	Chin H. Chu. Text. Mfr. Vol. 75, P. 38, 1949. Textile Lurzeen, Vol. 3, No. 12, P. 37; Vol. 4, No. 1, p. 33, No. 2, p. 23, No. 4, p. 23, 1948.
2.	Processing of ramie.	
3.	Degumming ramie by new Australian process.	W. F. Prehn. Text. Mfr. Vol. 74, p. 304, 1948.
4.	Ramie prospects and problems.	Fibres, Vol. 6, No. 2, p. 36, 38, 39, 1945.
5.	Ramie fibre, its substitutes and its processing.	A Gebhardt. Dent. Farberztg. Vol. 77, p. 141-142, 1941.

Patent Specification

1.	Removing ramie from its stalk.	David E. Patterson, U. S. P., 2, 355, 999, 15-8-1944.
2.	Treatment of ramie and similar fibres for textile purposes.	F. A. Svoboda and A. S. Kolnik. U S. P. 2. 353, 947, 18-7-1944.

3.	Fine fibres from ramie.	Celes Corpn. Ltd. and C. S. Townsend. E. P. 540, 123, 1942.
4	Production of fine fibres from ramie of China grass.	Celes Corpn. Ltd, and C. S. Townsend B. R. 13. P. 540, 123, 30-5-'40.
5	Degumming of vegetable fibres.	W. E. Billinghame and A. V. Billinghame B. P. 440, 637, 28-3-'34.
6.	Degumming of textile fibres	M. Mazetti B. P. 443, 636, 3-7-'34

Some work on the degumming of ramie fibre was actually carried out at the Harcourt Butler Technological Institute, Kanpur, when the fibre research unit was in operation. There was also a small nursery where along with other fibrous plants, ramie was also grown. Experiments and trials were given to the usual methods of degumming like steaming with or without pressure, treatment with mild caustic alkalies, use of alkali or alkaline earth salts and certain kind of success was also met with. It is, however, necessary to study the extraction of fibres at various stages of maturity of the plant. This problem is of sufficient industrial importance.

13 *Disposal of Industrial Effluents*—Sri R. L Powell of British India Corporation, Kanpur, drew the attention of this Committee to the problems connected with the disposal of industrial effluents Industrial effluents are of serious nature in almost all the factories and especially in tannery and woollen mills. Sometimes past, a Factory Effluent Enquiry Committee was also formed by Government and on the suggestions of this Committee, Sri S. N. Ghatak of the Harcourt Butler Technological Institute, Kanpur, analysed 63 different trade effluents of 25 different factories, for example, tanneries, distilleries, paper mills, dairy farms, straw-board factories, textile mills and others. Experiments were carried on specific gravity, temperature, colour, suspended matter, sedimentation, smell, pH, total solids, soluble solids, insoluble solids, organic and inorganic solids, free ammonia, albuminoid ammonia, nitric nitrogen, nitrate nitrogen, and oxygen absorption. 50,000 gallons of effluent treatment plant was designed by the workers of the Institute and it also got an acceptance from the Effluent Committee. The workers also suggested minimum standards of purity for using factory effluents on land for irrigation and also for discharging into rivers. The work needs further investigations and is of immense importance from the point of view of public health

This subject was also referred to the Director, All-India Institute of Hygiene and Public Health, 110, Chittaranjan Avenue, Calcutta 12. A note submitted by the Department of Sanitary Engineering Section of this Institute showed that a good deal of work has been done on the treatment of the following industrial wastes :

(*a*) Paper and strawboard.

(*b*) Coke and coke-oven phenolic wastes.

(*c*) Lac industries.

(*d*) Textile and miscellaneous industries.

Results of these investigations have been embodied in the form of scientific reports and popular pamphlets. A small unit is also working on problems relating to distilleries and sugar industries in the States of the Uttar Pradesh, Bihar and West Bengal. In this connection the publication of a paper 'Treatment and Disposal of Liquid Wastes from Lac Industry,' by G. K. Seth, S. Dey, and T. R. Bhaskaran, published in the Indian Journal of Med. Res, 44, 1, January, 1956, would be of interest. As a result of their investigation, it has been possible to devise methods for treatment of wastes from small as well as large size factories. The methods are :

(*a*) Chemical treatment followed by sedimentation ;

(*b*) Trickling filter treatment of the sedimented wastes from (*a*) ;

(*c*) Intermittent sand filtration treatment of the sedimented waste from (*a*).

Certainly as has been observed by the investigators, the choice of the method of treatment will depend on the size of the factory, skill for operation at the site, and the facilities available for the disposal of the treated effluent.

These authors have shown that by adding lime to the extent of 500 ppm. and sedimentation for a period of one hour, it has been possible to remove about 96 per cent of suspended solids and about 80 per cent. of B. O. D. (putrescible organic matter) from the waste. In places where the effluent can be directly disposed off in a water course, this primary treatment alone may be adequate to deal with the problem. The waste can be further purified by treatment in a trickling filter and the final effluent obtained by this treatment has B. O. D. and colour of the order of 150 ppm. By re-circulating the effluent through the filter (biofiltration), it is possible to bring about a further reduction in B. O. D. and colour. It is possible to use the trickling filter treatment in large size factories where there are facilities for construction and operation of this type of treatment. Intermittent sand filter treatment is another method by which the wastes can be purified and is best suited for adoption for smaller factories. Results obtained show that this treatment removes the organic matter and suspended solids from the waste to the extent of 95 per cent and it is possible to produce an effluent with 50 to 100 ppm. of B. O. D. and about 40 to 80 ppm. of suspended solids.

14. *Handmade paper and wool industry of Kalpi*—Sri R. S. Gupta, M. L. A., drew the attention of the Committee to the problems connected with hand made paper and wool industry of Kalpi. Kalpi is usually manufacturing handmade paper and paper products like filter paper, blotting paper, file covers, etc. The raw materials generally are old hemp and rope cuttings. While they are suitable for file covers, they are not so for the blotting and filter papers and even high grade D. O. papers. As a result of experiments carried out at the Harcourt Butler Technological Institute, Kanpur, it has been found that due to the use of paper cuttings for the manufacture of filter paper, the product of Kalpi has been found to contain an unusually high ash content. Moreover, on account of imperfect washings, samples of filter paper

produced contain free alkali. Although Kalpi is situated on the river bank of Jamuna, usually well water is used for paper making. This well water, as is so well known, contains high proportions of soluble inorganic salts including calcium salts and as such it not only increases the ash content of the filter paper but lowers the filtration properties due to blocking of pores and fibrillae. If Kalpi is to produce filter paper, blotting paper and other high grade paper, indigenous raw materials like sunn-hemp, rope cuttings, bamboo chips, rags, hosiery cuttings, etc. are only to be used and old paper and paper cuttings to be discarded. It is also necessary to have a central pulp supplying centre for supplying standard quality pulp to the artisans if a standard quality of the product is to be maintained. This will also enable the artisans to receive pulp at a comparatively lower price as production of pulp by individual workers will not only result in variations of the end products but will also make it costlier due to small scale and individual production.

Kalpi wool—Although not a very important centre, Kalpi produces certain amount of wool which is used by the local workers for the production of inferior quality of blankets and sweaters, etc. During the war period, considerable amounts of coarse blankets and sweaters and also raw wool were supplied to army, presumably not because of the high quality of the product but of the increased demand during the global war. The Kalpi wool industry has received a set back since the last war. If the civil population is expected to purchase Kalpi wool products, the quality needs improvement Since the raw wool is of poor quality, it would need physical and chemical treatment for improvement. Kalpi wool is quite characterised by short length of fibre, coarseness, presence of dust and adhering fat. Dust and other foreign matter could be removed by water washings (cold and hot), and fat by solvents, but these treatments were not enough to bring any softness to the wool. Treatment of the wool under pressure with steam, soaplye at room temperature at 100° C, and under pressure resulted in very little improvement of softness. The treated fibres were accordingly passed between wood revolving rollers and in some experiments they were needed. It was, however, found that the fibres suffer from ruptures and the felting properties also increased. Some other experiments were also carried out at the Harcourt Butler Technological Institute, Kanpur, using different chemical treatments, but in place of softening, the wool becomes tender and brittle. It was concluded that chemical and physical treatment does not bring appreciable softness to the wool. On the other hand, the felting properties increase and the wool becomes tender. If the quality of the wool is to go up, it is perhaps essential to improve upon the present breed of sheep

15. *Manufacture of Rayon grade pulp in India*—Sri B. L. Jaipuria, Swadeshi Cotton Mills, Kanpur, drew the attention of the Committee to this problem. He pointed out that at present, all the pulp is being imported from Canada and other countries and is prepared out of certain species of wood available at high altitudes. Sri Jaipuria wanted to know whether satisfactory results could be achieved with Indian Bamboo or wood. He also suggested the possibility of the manufacture of rayon grade pulp economically from fir wood (Abies Pindroes) which is available in plenty in Simla hills

and near about. The question of using this fir wood was not encouraging since it was doubtful whether the Forest Department will be able to supply this wood for rayon pulp purposes in sufficient quantities at an economic price. The Committee referred this problem to the President, Forest Research Institute, Dehra Dun, who in his correspondence indicated that experiments had been carried on rayon grade pulp at the Institute and the pulp produced there from blue gum (*Eucalyptus globulus*), bamboo (*Dendrocalmus strictus*) and wattle wood (*Acacia decurrens*) after necessary treatments would serve the requirements of the rayon industry. The Swadeshi Cotton Mill was prepared to make arrangements for giving trials to spinning tests of the rayon grade pulp prepared at Dehra Dun. At a later stage, it was pointed out to the Committee that this problem is being tackled at the highest Government level in conjunction with the Forest Institute, Dehra Dun, and therefore, the Committee could not pursue it further.

16. *Drilling Mud*—Sri Gujarmal Modi, Chairman, Associated Tube Wells India Ltd., Modinagar, drew the attention of the Committee to certain difficulties with respect of the cavity created in the tubewell under operation. He mentioned that for the purpose of avoiding the collapsing of the hole, an imported mud 'Wyogel' (drilling mud) is used. Sri Modi wanted the Committee to sponser some work on this drilling mud and its manufacture in India. The Committee referred this problem to the experts and the following agreed to take up the detailed study of this mud :

(1) Sheila Dhar Institute of Soil Sciences, Allahabad.

(2) Dr. A. C. Chatterjee, Chemical Analyst to Government, University of Lucknow, Lucknow.

(3) Director of Irrigation and Research, Roorkee, U. P.

Dr. S. P. Mitra of Sheila Dhar Institute of Soil Sciences, Allahabad, pointed out that the pure Indian Bentonite can be used in place of imported 'Wyogel' for drilling purposes. The treatment would depend on the density of Bentonite used. The best quality of finely powdered Kashmir Bentonite is put in a tank and is peptized by the addition of appropriate quantity of 0·01 per cent to 1.00 per cent of either sodium hydroxide or sodium carbonate solution so that the pH lies between 8 and 9. The mud suspension should have the following characterstics for the bentonite of density 75—78 lb./cu. ft.

(1) Viscosity	...	0 Min.	50 c. p.
		15 Min.	500 c. p.

The viscosity of the mass has sometimes a tendency to increase on standing. In such cases, the viscosity is decreased by the addition of appropriate amounts of Calgon (Imperial Chemical Industries Ltd.) or water glass or tannin materials or acid sodium pyrophosphate or Cellofas-B. Cellofas-B has the additional advantage of controlling fluid loss

(2) Sand should be less than 1 0 per cent. and the total of sand and silt should be less than 10·0 per cent. This is controlled by allowing the suspension to stand in settling tanks.

(3) Fluid loss at 100 p. s. i. pressure difference should be between 5-15 c. c. The fluid loss is adjusted by the addition of appropriate quantity of either gums or starch.

For Bentonite of density 80—90 *lb./C.ft.*

(1) pH between 8—10.

(2) Viscosity—Same as above.

(3) Sand and silt—Same as above.

(4) Fluid Loss—5—10 c. c.

After circulating the mass once, the heavy particles are first separated by allowing the whole mass to stand for some time in setting tanks. The finer particles are then separated by putting them on 16—18 mesh vibrating screen. The pH is again adjusted and it is then chemically analysed for dissolved salts, etc. before circulating the mass again.

Dr. Mitra says that these recommendations are tentative and will depend upon the composition of the strata of the soil where the tube-well is to be bored and he thinks that chemical and physical examination of the soil would be necessary before any final recommendation is made. The suggestions of Dr. S. P. Mitra were communicated to Sri Gujar Mal Modi who observed that it would not be possible for the people in the field to prepare the mud on the lines suggested. He was willing to finance the workers at the University or Institute in giving trial to the methods suggested and preparing a few maunds of drilling mud. The Committee is still anxious to pursue the matter as soon as the opportunity arises and an expert is available.

17. *Breaking strength of fabric*—The Swadeshi Cotton Mills, Kanpur, referred to the Committee a problem on establishing direct relation between the breaking strength of a fabric (grey loom state) under the conditions of :

(*a*) strength (breaking) of warp yarn used is broken,

(*b*) strength (breaking) of weft yarn used is known,

(*c*) definite number of ends per inch,

(*d*) definite number of picks per inch,

(*e*) and weave of the cloth i.e. yarn interlacement per inch of thread warp way and weft way are known.

A very specific example in this connection is quoted below :

A canvas cloth is to be manufactured to give 750 lb. breaking strength warp way and 550 lb. weft way in a test of 1″×8″ to be carried out on a constant rate of traverse machine with a traverse of 18″ per minute.

General conditions:—Texture :—Plain weave 1 up, 1 down,

Yarn :—3/10s yarn in warp,

4/10s yarn in weft,

(1) (*a*) What should be the number of ends per inch, if the lea strength of 10s single yarn is 150 lb. ?

(*b*) What should be the number of picks per inch if the lea strength of 10 s single yarn is 150 lb. ?

(2) (*a*) What should be the test of single 10s yarn, if the number of ends per inch is 58M ?

(*b*) What should be the test of single 10s yarn if the number of picks per inch is 30 ?

On the initiations of the Committee, the Swadeshi Cotton Mills, Kanpur, was informed that the Government Central Textile Institute, Kanpur, was prepared to take up the problem and the mills agreed to contact the Institute whenever and if necessary.

18. *Titanium Dioxide from Bauxite Sludge*—Sri T. F. Ross of the Kanpur Chemical Works in one of his letters drew the attention of the Committee to this problem. He stated that in some of the laboratories liquid chlorine is being used for this purpose, but since the substance is prohibitive in price, this, he thinks, could not be a commercial proposition. He wanted the Committee to find out whether some method could be devised by which an outlet for sulphuric acid was found; in that case their Chemical Works could use it with success. The Committee referred this problem to the National Chemical Laboratories where some work has already been done on this subject. Reference in this connection may be made to a paper by V. Damodaran and J. Gupta published in the Journal of the Scientific and Industrial Research, 1955. The authors have described in details their investigations on the preparation of titanium dioxide of high purity and good texture from bauxite sludge by the sulphuric acid process. The chief difficulty in applying the well known procedure for ilmenite is attributed to the presence of comparatively large amounts of alumina in the sludges. A method has been worked out by these investigators in which the sludge is first upgraded by leaching out a part of the iron and aluminium oxides with hydrochoric acid and subsequently removing most of the alumina from the sulphate solution as potassium alum, which forms a useful by-product of the process. The main solution of titanium sulphate is then treated in the conventional way to give titanium dioxide in an overall yield of 80 per cent. The laboratories report that the method suggested by them should work well for sludges containing 20 to 30 per cent titania and reasonably free chromium and manganese. Poorer grades may, however, be worked only after upgrading them by a suitable physical process.

The only problematic step in this process is the leaching of the sludge with hydrochloric acid both in regard to the cost of the chemical and the material of construction. By-product hydrochloric acid would be the cheapest material to use and as a constructional material for the leaching tanks, chemical stone-ware, rubber lined equipment, or even good wooden vats can be used.

In the opinion of the National Chemical Laboratory, somewhat more concentrated solutions of titanium sulphate than those actually reported in the publication can also be hydrolysed efficiently, giving a higher concentration of sulphuric acid on hydrolysis. Perhaps this acid can be tried in place of hydrochloric acid for upgrading the starting material.

The Committee has also subsidised a research project on titanium dioxide which is being worked out under the supervision of Dr. Sarju Prasad, Chemistry Department, Banaras Hindu University, Banaras.

19. *Suitable metal for making glass moulds*—Messrs. the U. P. Glass Works Ltd. Babjoi, suggested this problem to the Committee. The iron mould made in this country for the use of the glass industry are not as good as the foreign ones. The Committee referred this problem to the Director, National Metallurgical Laboratory, Jamshedpur and it would be of interest to reproduce below his observation in this connection.

"Blow holes in castings are caused mainly due to excess moisture in sand, low-permeability of sand, under baked pores, insufficient venting in the mould, oxidized metal, etc. Gas in the melt, hard ramming of the sand, hard or wet spots in core, low pouring, temperature, use of green ladles, etc. may give rise to hard spots in the casting thus adversely affecting the machinability of the material. Coarse grain structure may be due to improper metal composition (carbon equivalent too high, excessive use of graphitizers, etc.), high pouring temperature, etc. It is, therefore, very essential to take utmost precaution in every stage of melting and casting technique, so as to get a good and sound casting."

The Director also the refers to a book 'Analysis Casting Defects' published by the American Foundrymen's Association. The Committee advised the Uttar Pradesh Glass Works to contact the Director for further advice.

20. *Recommendations of the Committee on the expansion of Zoological Survey of India*—The Zoological Survey of India was constituted in 1916. Soon after the termination of the last war, the attention of Government of India was invited towards the reconstitution and expansion of this august body, and Lt.-Col. R. B. Seymour Sewell was invited by Government of India for suggestions. In 1955, the Ministry of Food and Agriculture appointed an *ad hoc* Committee for proposing a scheme for the expansion of the activities of this Survey. A Conference of selected zoologists was held in April 1955 at New Delhi in the Ministry of Natural Resources and Scientific Research. This Committee recommended that the activities of Zoological Survey be confined to systematic animal ecology and distribution of animals. The conference also suggested expansion with respect to the staff and workers. The Committee expressed its opinion on the question of expansion and enlargement of the survey and its reorganisation. The committee has supported the following proposals in this connection :—

(1) To considerably extend the Crustacea and Entomology sections.

(2) To encourage the study of carcinology.

(3) To divide the country into five regions as proposed for the purposes of survey work.

(4) To set up a unit at the headquarters for population studies.

(5) To appoint a surgeon naturalist.

(6) To create fellowships or studentships to be located not only in the Zoological Survey but also in Universities and Research Institutes.

(7) To enlist the help of outside eminent Zoologists working either in the country or abroad on the payment of remuneration basis.

(8) To give highest priority for extension of the library and the museum,

(9) To improve upon the standards of publications of the Zoological Survey.

The Committee further desired to communicate to the Ministry its fullest co-operation and assistance in the survey of fauna of the Uttar Pradesh It was also of opinion that full co-operation in this connection be sought of the talents and personnel available in Universities and other Research Institutes existing in the State.

RUBBER RESEARCH PROJECTS

Utilisation of molasses for the production of Synthetic Rubber—1. In a letter dated January 30, 1956, the Chief Minister drew the attention of this Committee to the study of the problem of manufacture of synthetic rubber from molasses available in this country and particularly in Uttar Pradesh. Out of the First Five-Year Plan, a sum of Rs. 20,000 was placed at the disposal of this Committee for subsidising research projects in this connection. The Committee constituted out of its own members a Rubber Research Project Sub-Committee consisting of—

(1) Dr. Sadgopal.

(2) Dr. Gopal Tripathi.

(3) Principal, Harcourt Butler Technological Institute Kanpur.

(4) Dr. S. N. Das Gupta.

(5) Sri Sita Ram Jaipuria.

(6) Dr. A. R. Kidwai,

(7) Dr. Satya Prakash (convener)

The Sub-Committee had its six meetings during 1956-57 and it recommended as follows—

(i) Attempts should be made to draw a plan for the production of such synthetic rubber as may be utilized for the manufacture of tyres or for the production of such rubber goods as soles for shoes, etc.

(ii) The fermentation techniques of molasses should be developed and utilized for the industry of synthetic rubber and allied products.

(iii) Most suitable type of rubber which may be manufactured in Uttar Pradesh is GR—S. It needs butadiene and styrene or polystyrene in the ratio 75 : 25, or 70 : 30.

(*a*) GR—S type of rubber needs primarily butadiene which can be manufactured from alcohol. However, for styrene, Uttar Pradesh will have to depend on benzene obtained from coaltar distillation and therefore, on the co-operation of the neighbouring States.

The nearest source for benzene is in Bihar (Messrs. Barari Coke Works, Dhanbad).

(*b*) In case, it is not convenient to import benzene from Bihar or petroleum products, from outside the State, the Sub-Committee recommends to concentrate on the manufacture of rubber of the type SKA or SKB or Bunas 32, 85 or 115.

(iv) (*a*) Molasses can also be profitably utilised for the production of acetone by Weizmanns process using *cl., acetobutylicum* or North rop's *B—Acetoethylicum.*

(*b*) Molasses as well as cheap grain might also be conveniently fermented, to yield 2, 3, butylene glycol. The ferment to be used for the purpose is aerobacter aerogenes.

2. In the opinion of the Sub-Committee all these processes enumerated under (i) have been very well worked out and are actually commercially utilized. It would be necessary to invite foreign technicians for setting up the plants and train our workers to start manufacture. The actual research problems would arise at a later stage.

3. In the opinion of the Sub-Committee, the production of acetylene would also be necessary for the manufacture of certain types of specialised rubber or for providing alternative methods for the preparation of starting materials for synthetic rubbers.

This State is very suitable for installing a calcium carbide plant, depending on cheap electricity which can be made available. The substance would furnish acetylene.

Ethyl alcohol should also be utilised for the manufacture of ethylene which would be necessary for the production of styrene and thiokol B.

4. The Sub committee is of opinion that at this stage, it would like to initiate research work on the following subjects connected with the problem of synthetic rubber manufacture:

(i) Fermentation of molasses and other indigenous substances available in the State for the production of ethyl alcohol, acetone, butanol and 2, 3 butylene glycol and allied products.

(ii) Catalytic production of various substances from alcohol (oxidation products, dehydration products and hydrogenation products).

(iii) Polymerisation of monomers to rubber like substances.

(iv) Synthesis of such new monomers (from indigenous raw materials) as may be utilized for the production of rubber like substances.

(v) Post-treatment of rubber to meet various requirements.

On the recommendations of the Sub-committee the following research projects were approved to be worked out by project assistants working on a salary of Rs. 250 per month.

Two at the Harcourt Butler Technological Institute, Kanpur

(i) Synthetic Rubber (preparation of a comprehensive report on the prospects of rubber industry in this country without economic details—Dr. D. R. Dhingra (Research Assistant, Sri J. C Sahgal).

(ii) To work on the preparation of Butanediols and other related fermentation products—Dr. B K. Jha, and Sri W. R. Damle.

One at the Allahabad University

Preparation of butanediols and other related fermentation products utilised in the synthetic rubber industry—Dr. Krishna Bahadur (Research Assistant Mrs. Ranganayaki)

Two at the Lucknow University

(i) Polymerisation of monomers to synthetic elastomers—Dr. Gauri Shankar Misra.

(ii) Production of 2:3 butanediols and (2-3) butylene glycol by molasses fermentation—Dr. P. S. Krishnan.

The work on the last two could not be started on account of technical difficulties.

5. *Early history*—The term 'synthetic rubber' applies to that group of high polymers which possess, to a greater or lesser extent, the physical properties of natural rubber. One definition suggested by H. L. Fisher refers to a substance that will stretch repeatedly to 300 per cent or more of its original length and will return rapidly and with force to its approximate original shape. It is implied that the polymers must be capable of conversion from a largely plastic to a largely elastic state by cross-linking reaction, such as vulcanization. None of the synthetic rubbers produced to date possesses all the characteristics of the natural rubber ; such as chemical structure, molecular weight and its distribution, etc. For this reason, some prefer to class these polymers as rubber substitutes ; elastomers, or elastoprenes

Trade names and trade marks of synthetic rubbers include such diverse types as GR—S, Polysar, GR—I, butyl, neoprene, Buna S, Buna N, Butaprene, chemigum, Hycar, Paracril, 'Thiokol, Silastic, Vulcaprene, Vulcollan, and Hypalon S—2, GR—S is an abbreviated form of 'Government Rubber Styrene, GR—I of 'Government Rubber—Isobutylene' and the German generic term 'Buna' arises from butadiene and sodium (Na), one of the first synthetic rubber processes studied.

Synthetic rubbers are often employed by the rubber industry to supplement natural rubber. In many applications, the special properties of synthetic rubbers allow their use in applications for which natural rubber is entirely unsuited. The most important type, GR—S is claimed to be preferred in 30 per cent and natural rubber in 35 per cent of all applications. The remaining 35 per cent is the field of active competition for both all-purpose elastomers, with the choice dependent on economic considerations. Transportation items (tyres and tubes) consume about two-thirds of the total rubber used in the industry.

For years, scientific investigators tried to make substitutes for natural rubber. As early as 1860, an Englishman, Grevill Williams, discovered that a white spongy elastic mass could be obtained from liquid distillate (isoprene of rubber). In 1879, a Frenchman, Gustave Bouchardat, mixed hydrochloric acid and isoprene and after heating them in a sealed tube, produced a solid mass resembling natural rubber. In 1884, Sir William Tilden prepared isoprene from turpentine and converted it into a rubber like product, thus being the first to prepare a synthetic rubber from a non rubber source. By 1909, the chemist Hoffman had started production in Germany of isoprene rubber on a small scale. Results were not too promising, so attention was turned to dimethylbutadiene, which could be synthesized from acetone, as the starting material for the manufacture of "methyl" rubber. About 2,350 tons of methyl rubber were manufactured at Leverkusen during the World War I. Methyl rubber H (Hart) was prepared by polymerizing the monomer in the presence of air for 10-12 weeks at 30°C. Methyl rubber W(W—weich or soft) was prepared by heating the monomer under pressure at 70°C for three to six months. A small quantity of a third type of methyl rubber B was prepared by allowing the monomer to stand in contact with sodium wire in a carbon dioxide atmosphere. This type of rubber was prepared by Badische Anilin u. Sodafabrik at Ludwigsbafen.

Continued research and development work by the Germans led to the development in the early 1930's of the Buna S and Buna N types of rubber by the emulsion polymerization process. Buna S was prepared from butadiene and styrene emulsified in soap and water and Buna N was prepared in a similar manner from butadiene and acrylonitrile. Some work was continued with systems using sodium metal as catalyst, but it was far overshadowed by the developments in emulsion polymerization. Sodium polybutadiene was manufactured on a fairly substantial scale in Russia and to a certain extent in Italy during this period.

In the meantime, two significant developments were taking place in the U S Patrick discovered that if a solution of sodium polysulfide and ethylene dichloride were mixed and heated, there separated out a solid mass with distinctly rubber like characteristics. Limited commercial production of this material known as Thiokol was started in 1930, and by 1935 had reached the rate of 500 tons per year. Since then, it has found a small but continuing place in rubber manufacturing operations, because of its excellent oil resisting properties.

Another outstanding development was that of neoprene (formerly called duprene), by the Du Pont Company. This was based on the researches of Father J. A. Nieuwland, who was interested in acetylene and its reactions. He observed in 1923 the formation of an elastic product when a gas obtained as a by-product in the formation of acetylene was treated with sulphur dichloride. Two years later, he made casual mention of this fact at a meeting of organic chemists at Rochester, New York. E. K. Bolton, a representative of Du Pont who was present made immediate arrangements for the work to be continued by his Company. Carrothers and his colleagues synthesized chloroprene by the addition of hydrogen chloride to vinylacetylene, and polymerized it to neoprene.

In the third decade of the present century a number of oil and rubber companies became more interested in synthetic rubber, and started to spend substantial funds on research and development programe with the objective of producing a special synthetic rubber superior to natural rubber. A large portion of this work centered around the emulsion polymerization of butadiene and acrylonitrile to make oil-resistant varieties similar to the German Buna N. However, hundreds of other monomers were included in these research activities. During the close of that decade, this programme resulted in pilot plant production from butadiene and acrylonitrile, of several oil resistant synthetic rubbers such as Hycar, Chemigum, Butaprene, and Perbunan (now known as Paracril).

Another interesting and very important development at this time was that of butyl rubber by the Standard Oil Company of New Jersay, based upon the prior discovery by the Germans of the saturated polymer, polyisobutylene (Oppanol B). The Standard Oil scientists discovered that if isobutylene was copolymerized with small percentage of isoprene or a similar diene, a rubber was obtained which could be vulcanized in special recipes.

As World War II approached, it was fortunately recognized in that country that steps should immediately be taken to safe-guard out rubber supplies. Arrangements were made to increase the amount of natural rubber shipped to that country, such as by a barter agreement with Great Britain to exchange cotton for rubber.

The U. S. Government established the Rubber Reserve Company through the Reconstruction Finance Corporation on June 28, 1940, to accumulate a stock pile of natural rubber and to develop additional sources of natural rubber in that hemisphere. As early as August 1940, consideration was given to a Government synthetic rubber programme. A programme was authorised in May, 1941, with the approval of the President, for the construction of plants with an annual capacity of 40,000 tons of GR-S (butadiene-styrene type rubber.

The production of synthetic rubber required large amounts of butadiene and styrene Oil and chemical companies contributed heavily to the problem of monomer supply, partly, with financial assistance from the Government. Butadiene up to that time had been made chiefly from petroleum, using the C4 hydrocarbons as the feed stock. Butylene was vaporised and dehydrogenated to butadiene. Many problems of purification had to be solved to produce butadiene of minimum purity of 99·5 per cent. suitable for synthetic rubber. Since considerable time was involved in completing the facilities for production of butadiene from petroleum, much of the initial production of GR-S was based on butadiene obtained from alcohol, a more expensive process which is still employed when the demand for butadiene exceeds the supply from petroleum sources.

6. *Production of rubber in India*—India has produced 22,400 tons of rubber in 1956 of which 80 per cent. came from the States of Travancore and Cochin. It is estimated that in the year 1960, there will be a shortage of 20,000 tons of rubber. In 1955-56, 65,630 tons of raw rubber worth Rs.1,95,57,000 and finished goods worth Rs.78,02,000 have been imported in India. In 1947, under the Rubber Act an Indian Rubber Board under the Ministry of Commerce and Industry, was set up at Kotyam. The Board, in order to step up the production as well as to check the import of raw and synthetic rubber has recommended to increase the area under rubber cultivation by 7,000 acres. But it is presumed that this will not meet up the total demand.

Table I—Net production of molasses in West U. P.

Table II—Net production of molasses in Central U. P.

Table III—Net production of molasses in East U. P.

Table IV—Net production of molasses in Bihar.

Table V—Total net production of molasses in India.

Table VI—Location of Distilleries and Production of Alcohol in U. P.

Table VII—List of distilleries in Indian Union.

TABLE I

Net production of Molasses in (maunds in West U. P.

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	Average
1	2	3	4	5	6	7	8	9
1	Doi Wali ...	B. G. ...	83,084	57,280	32,229	59,632	68,494	60,164
2	Modinagar ...	,, ...	123,605	59,625	89,787	129,185	150,245	110,472
3	Bijnor ...	,, ...	173,903	154,326	130,954	235,627	261,916	172,145
4	Pannen Nagar ..	,, ...	10 ,699	111,966	...	65,097	140,285	106,762
5	Mohiuddin Nagar	,, ..	135 675	27,035	90,293	144,890	143,255	107,633
6	Shamli ..	,, ...	215,854	135,911	170,301	206,791	195,203	184,812
7	Meliana ...	M. G. ...	158,548	64,020	95,464	210,230	241,440	153,941
8	Amroha ...	B. G.	216,867	142,624	151,809	224,189	319,216	210,941
9	Rampur (Raza) ...	,,	189,925	136,248	40,822	116 487	172,832	131,263
10	Durala ...	,, ...	228,420	82,428	132,458	234,842	203,618	176,955
11	Kashipur ...	M. G.	131,850	125,080	69,534	140,444	162,311	25,844
12	Rohan Kalam ...	B G.	179,865	88,761	113,690	189,465	218,931	138,104

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	Average
1	2	3	4	5	6	7	8	9
13	Raja-ka-Sahaspur	B. G. ...	206,494	115,542	119,256	209 880	266,973	183,629
14	Mowana ...	,, ...	174,028	85,918	124,859	205,985	159,954	130,149
15	Iqbalpur ...	,, ...	271,417	126,214	67,212	90,641	201,857	151,468
16	Dhampur ...	,, ...	222,133	151,286	116,75	195,630	243 051	185,771
17	Khatauli ...	,, ...	147,547	68,614	99,900	172,159	189,420	135,530
18	Mansurpur ...	,, ...	168,129	85,894	1.2,966	207,746	297,899	185,771
19	Seohara ..	,, ...	334,890	25,896	238,791	400,970	522,952	304,693
20	Sakhoti Tanda ..	,, ...	127,095	60,175	132,454	137,261	141,764	113,751
21	Simbhali ..	,, ...	154,569	79,040	110,001	179,299	216,676	149,917
22	Neoli ..	M. G. ...	179,101	123,708	74,961	185,046	189,179	140,399
23	Rampur (Bulad) .	B. G ..	188,699	135,658	45,227	114,299	195,723	139,521
24	Lhaksar ...	,, ..	197,233	116,931	80 398	166,765	192.303	150,726
25	Saharanpur ...	,, ...	265,.2	12,946	9,713	218,036	209,488	198,921
26	Deoband ...	,, ...	151,142	86,726	89,788	154,793	170,161	103,322
			Average 178,569	Average 110,039	Average 104,898	Average 174 981·2	...	...
			46,42,794	28,77,189	27,27,348	45,49,506	55,30 623	...

TABLE II

Net Production of Molasses in (maunds) in Central U. P.

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	Average
1	2	3	4	5	6	7	8	9
1	Aira ...	M. G. ...	80,539	41,536	38,718	74,527	140,192	75,101
2	Nawabganj ..	,, ...	124,722	118,787	48,886	115,687	86,751	98,967
3	Biswan ...	,, ..	144,413	83,774	59,494	106,212	133,046	105,388
4	Hargaon ..	,, ...	390,749	334,626	185,183	310,574·5	425,540	339,331
5	Maholi ...	,, ...	217,573	112,433	96,084	200,788·4	218,465	170,215
6	Bareilly	B. G. ..	141,208	95,581	63,178	142,934·2	225,111	133,811
7	Balrampur ..	M. G.	94,242	109,442	43,869	84,387	74,975	81,383
8	Golagokarannath...	,, ...	397,234	399,348	167,548	358,045	407,875	354,010
9	Tulsipur ..	,, ...	85,753	150,432	85,305	117,695	94,092	102,646

Serial no.	Place of Sugar Factoay	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	Average
1	2	3	4	5	6	7	8	9
10	Babhnan ..	M. G. ...	73,890	96,506	34,344	93,243·7	5.,165	69,630
11	Pil bhit ..	,, ...	270,649	211,4·2	154,817	308,985	314,956	311,354
1.	Baheri ...	B. G. ...	242,536	182,599	93,863	229,096	239,657	197,550
13	Hardoi ...	,, ..	191 157	67,771	90,474	151,276·5	...	125,170
14	Rosa ...	,, ...	94,055	...	50,377	103 392·4	141,590	122,354
			Average	Average	Average	Average		
		...	182,051	156,601	86,153	171,630	201,412	...
	Total ...	...	25,48,714	21,08,414	12,06,142	24,02,820	28,19,767	...

TABLE III

Net production of Molasses in (maunds) in East U. P.

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-66	Average
1	2	3	4	5	6	7	8	9
1	Jarwal Road ..	M. G. ...	110,748	68,339	42,067	122,470·9	129,057	94,536
2	Gauri Bazar ...	,, ...	71,799	94,298	39,894	100,340	87,306	78,707
3	Kath Kuiyan ...	,, ...	64,222	61,341	34,91	53,181	52,542	53,241
4	Walterganj ..	,, ...	65,990	115,196	39,717	114,647·5	40 935	75,297
5	Ghughli ...	,, ...	60,917	101,126	48,452	69,124·6	62,596	68,443
6	Shahganj ...	B. G. ...	93,110	97,909	30,220	96,189	44,296	72,945
7	Khalilabad ...	M. G. ...	56,937	64,640	28,841	71,600·4	63,910	57,186
8	Captanganj ...	,, ...	88,034	116,251	60,810	108,695·6	81,755	91,109
9	Padrauna ...	,, ...	84,372	79,014	47,525	52,009·1	58,907	68,365

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	A erage
1	2	3	4	5	6	7	8	9
10	Bisti	M. G. ...	62,392	83,737	36,584	103,269·6	34,880	67,173
11	Baitalpur ...	,, ...	76,563	95,144	40,039	98,704·7	85,999	79,290
12	Ramkola ..	,, ...	91,810	122,978	7 ,504	89,791·5	78,613	90,339
13	Siswa Bazar ...	,, ...	82,633	92,759	49,141	68,654	83,732	75,384
14	Deoria	,, ...	83,776	93,186	34,236	118,039	98,140	85,475
15	Purtapore ...	,, ..	...	82,199	...	...	...	82,199
16	Sardarnagar ...	,, ..	202 786	286,535	123,302	317,618	251,955	236,439
17	Burhwal ...	,, ...	96.292	64,316	39,005	77,757	71 624	89,799
18	Pipraich ..	,, ..	79,623	101,614	52,991	103,616·4	63,093	80,188
19	Chhitauni ...	,,	82,397	82,199	54,693	80,604·4	86.865	77,352
20	Mairwa ..	,, ...	59,131		34,798	91,931	89,805	68,916

21	Ramkola (Maheshwari).	„	...	58,143	72,342	54,922	89,928	70,140	69,095
22	Anandnagar	„	...	84,571	135,300	64,985	82,720·3	121,438	97,683
23	Bara Banki ...	„	...	117,134	81,410	65,160	117,261	117,209	97,635
24	Khadda ...	„	...	91,183	87,414	34,099	134,997	59,559	81,450
25	Lakshmiganj ...	„	...	61,890	79,114	50,053	73,373	66,255	66,127
26	Munderwa ...	„	...	52,544	71,851	32,006	94,978	31,805	56,637
27	Maudha ...	B. G.	...	...	...	...	99,978	60,600	77,789
28	Seorahi (Tam Koi Rd.)	„	...	101,601	106,754	76,225	106,539	92,626	93,549
29	Moti Nagar ...	M. G.	...	136,438	71,974	32,820	100,925	...	85,536
				Average 85,816	Average 96,804	Average 47,736	Average 101,369	...	...
	Total ...	...		23,15,032	26,00,208	12,88,852	27,36,963	21,90,643	...

TABLE 1V

Net production of Molasses in (maunds) in Bihar

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	Average
1	2	3	4	5	6	7	8	9
1	Harinagar ...	...	117,327	174,253	75,009	11,424	183,263	132,263
2	Bagaha ...	...	66,896	97,707	41,141	60,286	125,248	74,753
3	Sipewalia ...	...	68,358	84,024	35,847	72,649	107,877	73,751
4	Lohat ...	...	91,254	130,320	57,621	71,522	138,850	97,923
5	Moti Hari ...	...	55,954	78,175	56,989	86,750	113,921	78,358
6	Sakri ...	...	59,480	102,140	37,833	47,321	100,396	69,434
7	Guraru ...	...	70,181	43,927	12,035	...	44,280	34,085
8	Harkhu ...	...	76,887	83,893	42,233	79,841	112,517	79,994

9	Righa ...	...	87,010	90,822	45,165	73,555	142,003	87,913
10	Bihta ...	..	83.069	96,632	23,396	58,191	107,027	74,551
11	New Sawan ...	...	61,818	61,264	27,649	99,107	105,751	71,118
12	Majholi ...	...	101,989	132,935	77,243	118,833	170,201	120,240
13	Laurriya ...	...	115,889	138,347	60,273	102,866	163,778	116,231
14	Sitalpur ...	...	65,162	65,618	25,915	43,005	91,371	57,814
15	Chanpatia ..	...	86,577	105,236	51,971	78,225	82,480	80.898
16	Mirganj ...	...	...	...	43,169	32,850	114,940	63,650
17	Warsaliganj ...	...	...	...	94,880	120,297	89,023	101,385
18	Hanspur Road ...	...	115,894	149,765	94,881	127,094	171,067	131,730
19	Marhowrah ..	...	103,990	130,275	62,095	90,182	140,577	105,624
20	Panchrukhi ...	...	82,306	82,213	32,490	72,113	121,138	78,052
21	Samastipur ...	...	85,684	103,674	51,291	58,903	116,958	83,502
22	Sasa Musa ...	...	52,210	56,319	38,857	65,445	71,283	66,823
23	Sugauli ...	...	59,389	98,320	58,167	70,385	87,745	74,803
24	Narkatiaganj ...	...	84,540	125,412	63,593	89,020	157,750	104,063

Serial no.	Place of Sugar Factory	Railway	1951-52	1952-53	1953-54	1954-55	1955-56	Average
1	2	3	4	5	6	7	8	9
25	Burrah Chakia ...	...	69,777	...	55,155	78,592	186,030	92,020
26	Dalmianagar ...	...	345,282	144,845	60,848	107,200	138,871	159,369
27	Motipur ...	...	81,877	98,996	45,155	...	138,877	98,140
28	Ryan ...	...	53,223	74,676	24,105	41,358	88,610	56,395
29	Hathuna ...	...	95,455	105,825	42,233	100,821	...	61,083
			Average	Average	Average	Average		
			78,355	101,637	46,638	80,256	...	...
	Total ...	...	21,15,431	27,44,199	13,52,502	21,66,912	33,42,460	...

TABLE V

Total net production of Molasses in (Tons) in India

Year	West U. P.	Central U. P.	East U. P.	U. P. as whole	Bihar	India
1951-52	1,70,364·296	93,523·639	24,953·7	3,18,856·635	77,628·868	6,01,291·931
1952-53	1,05,585·9	77,371·2432	95,418·582	2,78,375·725	1,00,702·24	5,07,975·45
1953-54	1,00,073·432	44,261·165	47,296·647	1,91,631·274	49,631·632	3,43,188·974
1954-55	1,66,950·666	88,175·118	1,00,436·809	3,55,662·593	79 354·975	6.17,375·430
1955-56	2,02,985·64	1,03,311·015	80,462·209	3,86,756·864	1,23,794·9	7,22,175·523
			Average	3,12,237·018	86,222·5	5,38,408·461

(Figures in Tables I-V have been taken from the Indian Institute of Sugar Technology)

TABLE VI

Statement giving the location of distilleries and production of Alcohol in U. P.

Serial no.	Name of distillery	Existing capacity in gallons	Expansion sanctioned or recommended	Additional capacity recommended to be sanctioned by the Industrial Alcohol Committee
1	Central, Meerut ...	6,90,000	6,60,000	...
2	Daurala, Meerut ...	10,35,000	12,00,000	7,00,000
3	Shimbholi, Meerut ..	8,70,000	...	...
4	Shamli, Muzaffarnagar.	6,90,000	...	9,00,000
5	Ajudhia, Moradabad	6,90,000	6,12,000	...
6	Narang (Gonda) ...	6,90,000	6,60,000	...
7	Gola, Kheri ...	10,80,000	...	7,00,000
8	Hargaon, Sitapur ...	14,70,000	...	...
9	Baheri, Bareilly ..	9,75,000	...	...
10	Shankar, Deoria ..	16,80,000	...	...
11	Saraiya, Gorakhpur	19,65,000	...	...
12	Rampur ...	6,60,000	3,90,000	...
13	Mansurpur, Muzaffarnagar.	...	7,20,000	3,00,000
14	Seohara, Bijnore ...	...	13,20,000	...
	Total ...	1,25,25,000	55,62,000	26,00,000

(Figures have been obtained from Ministry of Industries, Uttar Pradesh, Lucknow.)

TABLE VII

List of Distilleries in Indian Union

Serial no.	Name of State	Name of Distillery	Installed Capacity per month	
			Power Alcohol (b. g.)	Commercial spirit 9 (b. g.)
1	Uttar Pradesh.	The Daurala Distillery and Chemical Works, Daurala, (Meerut District).	64,000	11,000
2	Ditto	The Central Distillery and Chemical Works, Ltd., Meerut Cantt.	44,000	11,000
3	Ditto ...	The Ajudhia Distillery, Raja Ka-Sahaspur (Moradabad District).	44,000	11,000
4	Ditto ...	The Simbhaoli Industries Ltd, Simbhaoli, E. I. R., P. O Baksar (district Meerut).	50,000	12,000
5	Ditto ...	The Shamli Distillery and Chemical Works, P. O. Shamli, (Muzaffarnagar).	44,000	11,000
6	Ditto ...	The Narang Industries Ltd., Nawabganj, District Gonda.	44,000	11,000
7	Ditto ...	The Shankar Distillery and Chemical Works, Ltd., Captanganj (Deoria).	1,00,000	2 ,000
8	Ditto ..	The Oudh Sugar Mills Ltd., Hargaon, District Sitapur	60,000	15,000
9	Ditto ..	The Hindusthan Sugar Mills, Ltd., Golagokarannath.	64,000	11,000
10	Ditto ...	The Kesar Sugar Works Ltd., Behari (District Bareilly)	67,500	7,500
11	Ditto	The Saraya Distillery, Sardarnagar.	...	...
12	Ditto ...	The Rampur Distillery and Chemical Co. Ltd., Rampur (U. P.)	25,000	30,000

Serial no.	Name of State	Name of Distillery	Installed Capacity per month	
			Power Alcohol (b. g.)	Commercial Spirit 9 (b. g.)
13	Uttar Pradesh.	The Kanpur Sugar Works Ltd., (Distillery) Cooperganj, Kanpur.	...	30,000
14	Ditto ...	The Co-operative Co. Ltd., (Distillery), Saharanpur.	...	15,000
15	Ditto	The Standard Refinery and Distillery Ltd., Unnao, E. I. R.	...	45,000
16	Ditto ..	The Indian Distillery, Anwarganj, Kanpur	...	30,000
17	Ditto	The Dyer Meakens, Lucknow ...	...	30,000
18	Ditto ...	The Carew and Co. Ltd., Rosa, District Shahjahanpur.	...	30,000
19	East Punjab.	The Punjab Distilling Industries Ltd., P. O. Distillery Khasa (E. P.).	...	50,000
20	Ditto ...	The Karnal Distillery Co. Ltd., Sadar Bazar, Karnal.		30,000
21	Bombay	The Government Central Distillery, Nasik Road, District Nasik.	...	83,333
22	Ditto ...	The Walchandnagar Industries, (Distillery Ltd., Walchandnagar), district Poona.	...	60,000
23	Ditto	The Alembic Chemical Works Co. Ltd., Baroda.	..	15,600
24	Bihar ...	The S. K. G. Sugar Ltd. Mirganj.	50 000	25,000
25	Do.	The Bihar Sugar Works, Pachrukhia.	40,00	50,000
26	Do.	The Cawnpore Sugar Works Ltd., Marhowrah (Bihar).		27,000

Serial no.	Name of State	Name of Distillery	Installed Capacity per month	
			Power Alcohol (b. g.)	Commercial spirit 9 (b. to)
27	Bihar ..	The Manpur Distillery, Manpur (District Gaya).	...	..
28	Madras .	The Indian Sugars and Refineries Ltd., Hospet (District Bellary).	...	40,000
29	Do. ...	The East Indian Distilleries and Sugar Factories Ltd., P. B. no. 12, Madras.	...	60,000
30	Do.	The Deccan Sugar and Abkkhari Co., Ltd., P. B. no. 12, Madras.	...	40,000
31	West Bengal.	he Russa Distillery, Tollyganj, Calcutta,	...	60,000
32	Ditto ...	The Crew and Co. Asansol ...	...	...
33	Ditto ...	The Bengal Distilleries Co. Ltd., Konnagar (District Hoogly).	...	...
34	States ...	The Hyderabad Constructions Co. Ltd., P. B. no. 109, Hyderabad) Dn.	59,733	14,933
35	Do. ...	The Mysore Sugar Co. Ltd., Sri Jayachamaraja Wadyar Road, Banglore 2.	59,733	24,933
36	Do. ...	The Jagjit Distillery and Allied Industries Ltd., Hamira, East Indian Railway (District Kapurthala), PEPSU.	...	83,334
37	Do. ...	The Cox Distillery, Nowagong, Vindhya Pradesh.	...	20,000
38	Do. ...	The Central India Chemicals Ltd., Sehore (Bhopal State), G I. P.	...	15,000
39	Do. ...	The Travancore Sugars and Chemicals Ltd , Trivandrum Travancore State).	...	15,000
		Total ...	8,15,966	9,95,153

7. Under the directions of this Committee Sri J. C. Sehgal, the project assistant under the supervision of Dr. Dhingra, Principal, Harcourt Butler Technological Institute, Kanpur, not only collected the statistics but also attempted to work out the economics of various synthetic processes available for the manufacture of synthetic rubber. The main raw material required for the production of alcohol is molasses. The sugar factories are spread over whole of the State and produced 2,86,759 tons of molasses in 1956. At present the State is producing 6030312 B. G. (21,090 tons) of alcohol, consuming correspondingly 1,27,900 tons of molasses. The net total production of power alcohol at the end of the Second Five-Year Plan if the distilleries, with the existing and additional capacity, work at full, will be 2,04,87,000 gallons and molasses consumed thereof 4,30,500 tons. It has been estimated that 15,000 tons of butadiene will consume 35,950 tons (85 %) or 10·36 million gallons of alcohol approximately. The power alcohol consumed in producing ethylene for the manufacture of styrene will be 4,113 tons and this corresponds to consumption of molasses of the order of 24,900 tons. The production of molasses by new sugar factories along with additional capacities for the old ones will be about 2,15,852 tons by 1958.

Steps for the manufacture of synthetic rubber

8. It is suggested that Buna S would be the most suitable type of rubber which could be manufactured in this country from alcohol derived from molasses.

9. *Materials utilising molasses*—The raw materials for Buna are acetylene, ethyl alcohol, petroleum and petroleum gases. It will be necessary to convert alcohol into butadiene. Amongst the various processes known in this connection the most prominent one is the aldol method, involving conversion of acetaldol to butylene glycol—2, 3. In its original form, the process consisted of four steps—

(1) Oxidation of ethanol to acetaldehyde.

(2) Condensation of aldehyde to aldol.

(3) Reduction of aldol to butylene glycol—2, 3.

(4) Dehydration of butylene glycol—2, 3 to butadiene.

In Russia, butadiene is directly produced through the cracking of alcohol at 400—420° in the presence of catalysts, like alumina and zinc oxide.

10. *Manufacture of styrene*—The raw materials for the manufacture of this substance are ethylene and benzene. Ethylene is produced from alcohol in the presence of a catalyst like aluminum chloride. Benzene is available in Bihar and will be produced in sufficient quantity with the existence of iron and steel plants. Styrene is produced by alkylation of benzene and then dehydration. It is also possible to get styrene as such from the iron and steel plants existing in this country.

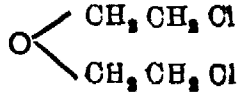
Possibility of manufacture of thiokols in India

11. For the manufacture of thiokols, the chief raw materials required are—(1) sodium sulphide, (2) sulphur and (3) dihalides, most important amongst them being—

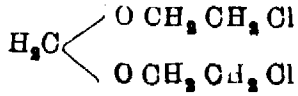
(1) ethylene dichloride, Cl CH_2. CH_2 Cl.

(2) glycerol dichlorohydrin, Cl CH_2 OH (OH) CH_2 Cl.

(3) dichlorodiethyl ether



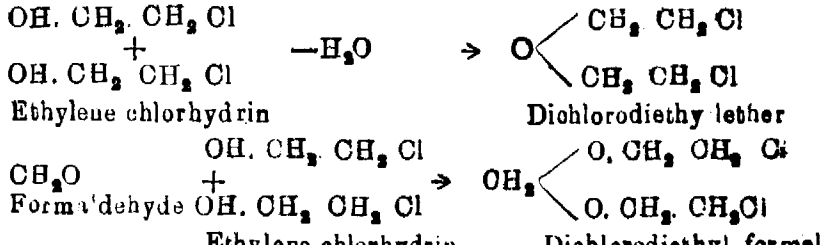
(4) Dichlorodiethyl formal



Sodium sulphide, Na_2S.—It is commercially manufactured by reducing sodium sulphate with coke or hydrogen and all these commodities are easily available in India. We have abundant deposits of sodium sulphate in Didwana and many other regions and hydrogen gas is available as a bye-product in caustic soda manufacture. Sulphur is the only commodity that will need imports from abroad. All other organic chemicals are either available in this country or can be manufactured from raw materials, available abundantly in India as discussed below.

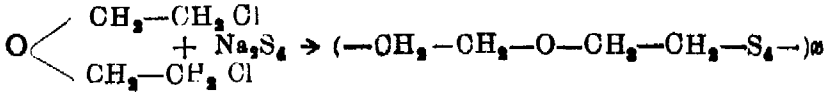
Ethylene dichloride Cl CH_2 CH_2 Cl—Under the auspices of the Council of Scientific and Industrial Research, the Shri Ram Institute for Industrial Research, Delhi, has developed a process for the manufacture of ethylene dichloride from alcohol and chlorine. This process has already been leased out by the National Research Development Corporation, Government of India, to the Delhi Cloth Mills Chemical Works, Delhi and soon, therefore, we can hope to have a steady supply of this vital chemical in our country.

Glycerol dichlorhydrin, Cl. CH_2 CH (OH), CH_2 Cl—This chemical is easily obtained by condensation of glycerine with concentrated or anhydrous hydrochloric acid in the presence of certain catalysts like acetic acid etc. Both the reagents required are not only abundantly available but need immediate industrial utilization for the healthy growth and development of electrolytic caustic soda and soap industries where they are available as bye-products. Both dichlorodiethyl ether and corresponding formal are ethylene chlorhydrine products, the former being obtained by dehydration and the latter by its condensation with formaldehyde.



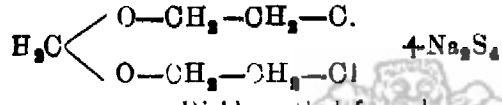
Ethylene chlorhydrine is obtained by either chlorination of ethylene in presence of water or by condensation of ethylene oxide with hydrochloric acid. Ethylene can easily and economically be produced from ethyl alcohol.

Thus in short, from our immediate point of view, the two products most vitally suited are ethylene dichloride and glycerol dichlorhydrine, yielding Thiokol 'A' and Vulcaplas types of thioplast. Vulcaplas are soft type of materials produced in Great Britain and which are based on glycerine dichlorhydrine.

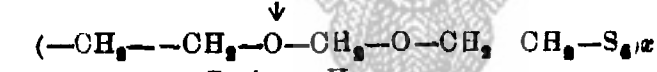


Dichlorodiethyl ether — Thiokol B

Ethylene dichloride — Thiokol A



Dichloroethyl formal



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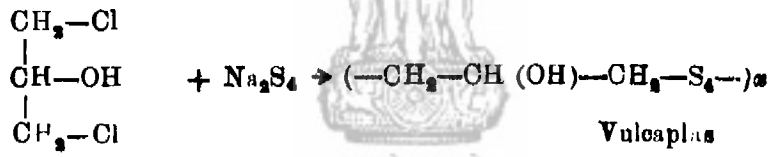

Glycerol Dichlorhydrin. — Vulcaplas

Manufacturing process

12. In comparison with the manufacture of any other synthetic rubber, that of thioplasts is much simpler and easier and needs much less capital investment. All that is done is the preparation of a suitable polysulphide with requisite quantity of sulphur and its condensation with corresponding dihalides by refluxing. The resin formed is thoroughly washed to get rid of the excess of polysulphide and desulphurised by boiling with caustic soda solution.

13. ***Field of application.***—Thiokols are practically unaffected by oils, fats, greases and petroleum solvents and naturally, they are being extensively used for the manufacture of such articles as are likely to come in daily contact with these things. Special mention may be made of hose-pipes, gaskets, packing, etc. In fact, the thiokol was also used for the inner lining of the self-seating Mareng Cell gasoline tanks that were used on the allied nations bombers and fighters during the Second World War. Thiokols also formed the chief raw material for the fabrication of mobile gasoline storage tanks that accompanied these forces.

Being thermoplastic and inert towards many organic solvents and inorganic reagents, thiokol is extensively used for spray coating of metallic surfaces. These thiokols-coated equipments are extremely useful for the refrigeration and marine industries where a long exposure to highly salty water is very common.

Recently, epoxy resins mixed up with thiokols have been introduced into the paint industry. These paints have extremely good adhesive property of epoxy resins and chemical inertness of thiokols, with the result that they are specially useful for painting hulls of boats, ships or other sea-going vessels.

In addition to all this, the remarkable resistance of thiokols against the effects of sunlight, air, moisture and ozone suggests a thousand and one applications in chemical industries.

14. ***Possibility of the manufacture of Perbunan, Hycar O. R. and Chemigum.***

Perbunan—It is a copolymer of butadiene and acrylonitrile.

Basic raw materials —Mainly ethyl alcohol.

Butadiene—It is manufactured from ethyl alcohol by a number of processes and through a variety of intermediate stages.

(1) Oxidation of ethanol to acetaldehyde.

$$CH_3\,CH_2\,OH + O \rightarrow CH_3\,CHO.$$

(2) Condensation of aldehyde to aldol.

$$CH_3\,CHO + CH_3\,CHO \rightarrow CH_3\,CH\,(OH)\,CH_2\,CHO.$$

(3) Reduction of aldol to butylene glycol.

$$CH_3\,CH\,(OH)\,CH_2\,CHO \rightarrow CH_3\,CH\,(OH)\,CH_2\,CH_2\,OH.$$

(4) Dehydration of glycol to butadiene.

$$CH_3\,CH\,(OH)\,CH_2\,CH_2\,OH \rightarrow CH_2{=}CH{-}CH{=}CH_2 + 2H_2O$$

In Russia, butadiene is produced by Lebeder Process direct from ethyl alcohol by passing the vapours of it at 400—425°C over a catalyst mixture of alumina and zinc oxide.

Acrylonitrile—Is also produced from ethyl alcohol by the following sequence of reactions :

(1) Formation of ethylene from ethanol.

$$CH_3\,CH_2\,OH \rightarrow CH_2{=}CH_2 + H_2O.$$

(2) Oxidation of ethylene to ethylene cyanhydrin.

$$CH_2{=}CH_2 + HCN + O \rightarrow OH\,CH_2{-}CH_2\,CN.$$

(3) Dehydration of ethylene cyanhydrin.

$$OH{-}CH_2{-}CH_2\,CN \rightarrow CH_2{=}CH\,(CN).$$

Manufacture.—Perbunan is manufactured by emulsion co-polymerisation of butadiene and acrylonitrile. It has a nitrogen content of 7 per cent, corresponding to about 25 per cent acrylonitrile. It is very economical to manufacture Perbunan at the site of Buna S plant.

Hycar O. R.—Hycar is trade name for a group of synthetic rubbers which have been available since 1939. The leading type is Hycar O. R., a synthetic rubber based on butadiene and acrylonitrile. It contains about 25 per cent of the latter.

Chemigum.—Chemigum is the name for the series of elastomers derived from petroleum. According to Dinsmore, it is a butadiene co-polymer of a modified Buna type. While butadiene is the main constituent, there are various synthetic resins, other than styrene and acrylonitrile which have been successfully developed as co-polymer.

15. *Possibilities of the manufacture of styrene in India*—Styrene as such will be available, wherever we have our steel plants.

For its manufacture, the chief raw materials are=(1) benzene and (2) ethylene.

Benzene :—It is available from Bararee Coke Oven Co. Ltd., and Burrakur Coal Co. Ltd., Manbhum, Bihar. It will be available in abundance from Rourkela, Bhilai and Durgapur Steel Plants.

Ethylene :—It is commercially manufactured by the dehydration of ethyl alcohol in presence of a catalyst, aluminium chloride. The Council of Scientific and Industrial Research, with the co-operation of Sri Ram Research Institute, Delhi has developed a method, for its manufacture. The basic chemistry of styrene process is outlined by two simple equations. Ethyl benzene is produced by the alkylation of benzene with ethylene at 95°.

$$C_2H_4 + C_6H_6 + [AlCl_3] \rightarrow C_6H_5C_2H_5.$$

Purified ethyl benzene is then dehydrogenated catalytically in presence of steam at 660° to give styrene.

$$C_6H_5C_2H_5 \rightarrow C_6H_5.CH=CH_2 + H_2$$

Styrene.

(i) *Ethyl Benzene production step* (Alkylation)—When ethylene and benzene react in the presence of aluminium chloride and hydrogen chloride in an anhydrous system, alkylation of the benzene ring occurs to produce ethyl benzene and higher ethylated benzenes. The purity of ethylene ordinarily consumed averages 95%, although the process has operated satisfactorily with concentration as low as 38% The purity of benzene should be little above 99% Total sulphur should be below 0·10 per cent.

Aluminium chloride with minimum purity of 97·5 per cent is used as an alkylation catalyst. In order to operate at high catalyst efficiencies, hydrogen chloride must be added as a promoter. This is accomplished by furnishing the reaction mixture with ethyl chloride which in turn provides the desired HCl as well as ethyl group.

(ii) *Ethyl benzene dehydrogenation step*—The second important step in the manufacture of styrene is the dehydrogenation of ethyl benzene at 630°.

In this exothermic reaction, a volume increase accompanies dehydrogenation, so decreased pressure favours its progress. This reaction is favourably carried out under high temperatures and partial pressures.

APPENDIX A

Production of 2,3—Butylene Glycol by Fermentation—(Report by Dr. W. R. Damle and Sri K N Goel, Harcourt Bu ler Technological Institute Kanpur.

The culture of aerobacter aerogones received from the Northern Regional Research Laboratory, Preoria, U. S. A. which had shown good growth in glucose phosphate-medium was gradually acclimatised for growth on Indian sugarcane molasses. The process of acclimatisation consisted of in successive transfer of the culture from a 100 per cent synthetic medium to media containing increasing percentage of molasses and decreasing percentage of synthetic media; so that ultimately the medium consisted of molasses only. Of course, molasses being deficient in nitrogen and phosphate, external nutrients to supplement these had to be added. Calcium carbonate is also necessary to act as a buffer against variation. The organism when grown in molasses shows good growth after 24 hours of inoculation and the fermentation appears to be complete within 48 hours. It is interesting to note that the growing culture, if it is not separated from the fermented wash within a reasonable time after complete fermentation, loses its property of active growth. It is, therefore, necessary that maintenance of the culture in active state by regular propagation is carried out.

Determination of the quantity of the diol present in the fermented wash can be carried out by following the method of Adams (Canadian J. Research, Vol. 24 F. 1946). The method suggested by workman using hydroxylamine was found to be unsatisfactory. It was noticed that the yield of diol was 17 per cent of the sugar present. This is no doubt low as compared with the yields obtained by workers in U. S. A. who have reported an yield on 80 per cent based on sugar contents. However, the media used by them are not from molasses but maize, wheat, wood hydrolysate, corn etc. It is, however, felt that better yields can be obtained from molasses also by pretreatment of the wort in order to remove inorganic impurities and by selection of proper nitrogen and phosphorus nutrients.

The recovery of the butylene glycol from the fermented wash is a matter of great headache indeed. Fractional distillation of the wash after filtration was tried but it did not yield successful results, the glycol getting decomposed during the operation. Solvent extraction by butanol and others was tried. Although ethereal extraction does give encouraging results, the process requires continuous extraction for at least one week before any appreciable quantity of the glycol can be recovered. Moreover, the bulk of the wash has to be first reduced before ethereal extraction can be carried out, and this operation of the evaporation of the liquid to a small bulk *in vacuo* also is a very tedious process which in the laboratory sometimes takes well over two working days. It is intended to try "steam stripping" as recommended by Wheat (Can. J. Research, 1953) as soon as the facilities are available. It is proposed to procure the design of the apparatus suggested by Wheat and to fabricate the unit locally.

Attempt is also being made to try the growth of aerobacter aerogenes in spent wash, a raw material which can be available in plenty in India. It has been found that the micro-organism shows good growth in spent wash after extra nitrogen, phosphorus and calcium carbonate are added to it. Further work on this fermentation is still in progress.

APPENDIX B

Experiments on butanal acetone fermentation and 2·3– butanediol fermentation.

Three strains of *clostridium acetobutylicum* isolated locally and called butyl-1, butyl-2 and butyl-3 were found to give good growth and fermentation when grown in the following media—

(A) *Glucose peptone phosphate medium.*

Glucose	...	....	...	... 2 per cent
Peptone	...	...	...	... 0·7 „
Potassium phosphate	..	...	—	0·1 „
Yeast phosphate	..	..	...	100 ml.

(B) *Sheep brain medium*—

Brain	...	...	...	... 79 gms.
Water	...	..	...	... 80 ml.
Peptone	...	..	...	.. 3·2 gms.
Potassium phosphate	..	...		... 0·15 gms.

The cultures were, therefore, tried in media prepared from maize (6 per cent solution), potato, molasses while the growth in maize was found to be satisfactory, that in potato was surprisingly poor, molasses, when used as such also indicated poor growth. Different types of molasses obtained from various distilleries were, therefore, analysed regarding their important constituents. On an average, they were found to contain 48 55 per cent total sugars, 0·2—0·4 per cent phosphates and 1-2 per cent total nitrogen. The deficiency of nitrogen and phosphorus was in subsequent experiments supplemented by addition of external nutrients. The following substances were separately tried as sources of nitrogen.

(1) Ammonium sulphate.

(2) Asparagine.

(3) Peptone.

(4) Aspartic acid.

(5) A mixture of chemically pure amino acids.

(6) Casein hydrolysate.

(7) Yeast extract plus ammonium salts.

Fermentation was found to be better in 3, 5, 6, 7 thus indicating the need of complex mixture of various nitrogen sources for good fermentation. Peptone and cane in hydrolysate were particularly useful A fresh experiment using molasses diluted with yeast water and containing ammonium sulphate as nitrogen sources was performed and the results indicated good growth and fermentation.

Calcium phosphate or superphosphate, both were found to be good suppliers of phosphorus.

2, 3 *Butylene glycol*—Cultures of *Aerobactor aerogenes* received from the National Chemical Laboratory Poona and Northern Regional Research Laboratories U. S. A. are being examined. The culture from Poona failed to show good growth on glucose/urea medium but some growth appears to take place when grown on glucose/liver extract/ peptone media. The yield of butylene glycol, however, was very poor. We are finding great difficulty in isolating the final product. Both other extraction and steam stripping were tried, but the results are not good:

The culture from U. S. A. however, shows very good growth in the following medium.

Glucose	...	...	...	...	50 gms.
$MgSO_4\ 7H_2O$	...	...	...	...	0·25 ,,
KH_2PO_4	...	...	...	..	0·60 ,,
$CaCO_3$	...	...	...	...	5·0 ,,

Urea (to be added just before inoculation) 0·2 gms.

Vigorous fermentation and growth is seen at the end of 24 hours. It is now proposed to produce larger quantities of butylene glycol by this organism and to investigate its fermentation characteristics when grown on molasses.

APPENDIX C

STUDIES ON 2, 3 BUTANEDIOL FERMENTATION

(Report by Dr. Krishna Bahadur and S. Ranganayaki, Allahabad University, Allahabad).

2, 3 Butanediol fermentation has drawn the attention of biochemists and fermentologists all over the world because it is not only easily converted into 1-3 butadiene, a basic substance used in the preparation of Buna type rubber, but its derivatives have many potential uses as for antifreeze agents, solvents, softeners, plastics etc. It is produced by a number of micro-organisms of different types and this made the biochemist probe into the mechanism of the formation of 2,3 butanediol with a view to increase its formation to a manufacturing scale.

The chief difficulty in the production of 2,3 butanediol is its low yield. A review on the subject has been made by Ledingham, Adams and Stanier (1), *Serratia marcescens* (2), and *Bacillus subtilis* (3) were taken up by us for study and we investigated the influence of various factors as concentration of carbohydrate in the fermenting mixture, presence of different sources of carbon etc, with a view to find out possibilities of fermenting a concentrated mixture so that the difficulty of separating 2,3 butanediol from the fermenting mixture, may be minimised.

The influence of small quantities of milk in *Serratia marcescens* and *B. subtilis* cultures has also been investigated and it was observed that though it does not very much influence *B. subtilis*, it affects *S. marcescens* profoundly in its 2,3 butanediol production.

A great emphasis has been laid by workers on this field on keeping the concentration of phosphate high in the wort for getting a high yield of 2,3 butanediol in the fermentation by *B. polymyxa* (4) and *S. marcescens* (5) However, use of this high concentration of phosphate is uneconomical and we investigated the optimum concentration of phosphate for the formation of 2,3 butanediol.

The addition of calcium carbonate to neutralise the free acid formed in the fermenting work has been found to favour the formation of the diols, by certain authors (6) They believe that the decrease of the pH of the media by the accumulation of the acid in the culture decreases the 2,3 butanediol formation. We investigated this matter and have come to the conclusion that the addition of Ca CO_3 in no way helps in increasing the yield of diol but actually decreases the yield of diol in the cases studied. It is probably due to the removal of the acids formed from the field of reaction which according to Adams and Stanier (7) are important intermediates in the formation of 2,3 butanediol from carbohydrates.

The influence of zincions in the formation of 2, 3 butanediol has also been investigated and it has been observed that under certain conditions, it increased the yield of diol.

A number of micro-organisms have been discussed which produce more or less quantity of 2, 3 butanediol when they are grown on different carbohydrate substrates. We have studied the yield of diol by a number of microorganisms using starch and cane sugar as the source of carbon under Indian conditions. It was observed that a few of them can be economically employed for the production of 2, 3 butanediol.

Certain experiments using molasses as the substrate and different 2, 3 butanediol fermenting organisms have been preferred and it has been observed that molasses can be employed successfully for the diol production. The details of the molasses fermentation are under investigation.

Experimental procedure—Culture media were prepared containing the materials given in the tables. They were sterilised in an autoclave at 15 lb. pressure. They were cooled and seeded with traces of the organisms under investigation. The cultures were incubated at 35° The period in every set is mentioned in the tables.

After incubation, the alcohol, acid and sugar (reducing and non-reducing) contents of the culture were estimated.

For the estimation of butanediol the following method was used.

5 c. c. of the culture solution were taken in tube and to this excess of saturated bromine water added. The tube was sealed and heated in a water bath for exactly three minutes. After this it was cooled in a dark cool place. The tube was broken and the contents transferred to a distilling flask where the excess bromine was neutralised by a dilute solution of sodium sulphite, Then 5 c. c. ferric chloride solution 45°B E) was added to this and distilled. The distillate was collected in an acidic solution of 2, 4 dinitrophenylhydrazine hydrochloride and the resulting hydrazone kept over night in the solution itself to ensure complete precipitation. The precipitate was filtered and weighed and from this weight the amount of diol was calculated.

Observations—

The results obtained are tabulated below :

TABLE I

Influence of Concentration of Carbon Source

Source of carbon	Concentration	Name of organism	Yield of butanediol in gms. in 100 c. c.	Gms carbon of source consumed	Percentage yield on the basis of carbon source consumed
	Per cent				
Cane sugar ...	3	*Serratia*	0·032	0·54	5·74
	6	*marcescens.*	0·081	0·20	40·1
	12		0·040	0·50	80·0
Cane sugar ...	3	*Bacillus*	0·388	2·25	16·9
	6	*subtilis*	0·376	4·5	8·4
	9		0·38	5·06	7·5
	12		0·331	3·77	8·8
Starch	3	Ditto	0·004	2·16	0·15
	6		0·004	4·86	0·09
	9		0·004	7·31	0·05
	12		0·004	10.88	0·04

The cultures initially contained—

Phosphate ... ... 0·3 per cent

$MgSO_4$ ... ... 0·08 ,,

$(NH_4)_2SO_4$ ... ... 0·17 ,,

Source of carbon as given above

Period of fermentation—30 days

TABLE II

The influence of milk on *S. marcescens*

Quantity of milk	Acid formed in gms eqvt.	Red sugar formed in gms.	Total sugar consumed	Butanediol formed in gms.	Per centage yield on the basis of sugar consumed
0 c. c.	0·0004	0·22	1·01	0·17	16·8
1 c. c.	0·0006	0.3	0·95	0·23	24·2
2 c. c.	0·0005	0·73	1·77	0·30	16·9
3 c. c.	0·0008	0·93	1·38	0·38	27·5
4 c. c.	0·000	0·98	1·86	0·37	19·9
5 c. c	0·0007	0·31	1·65	0.28	16·9

Initially the cultures contained—cane sugar—3 per cent, phosphate —0·3 per cent $MgSO_4$—0·08 per cent, $(NH_4)_2 SO_4$—0·17 per cent.
Period of fermentation—30 days.

TABLE III

Influence of $CaCO_3$ on *S. marcescens* and *B. Subtilis*

Source of carbon	Organism	Ca CO_3 in gm.	Starch or sugar consumed in gms.	Butanediol formed in gms.	Percentage yield on the basis of source of carbon consumed
Cane sugar ...	*B. subtilis.*	Nil	1·81	0·481	26·6
		2 gm	2·44	0·097	3·98
Starch ...	,,	Nil	2·68	0·053	1·98
	S. marcescens.	2 gm.	3·0	Negligible	...
Cane sugar ..		Nil	0·98	0·085	8·67
		2 gm.	1·7	3·057	3·35
Starch ..	,,	Nil	...	0·178	...
		2 gm.	3·0	0·036	1·20

S. m. culture contained 2 per cent milk.

[The cultures originally contained—phosphate—0·15 per cent, MgSO —0·08 per cent, carbon source 3 per cent, $(NH_4)_2 SO_4$—0.17 per cent].

Period—30 days.

TABLE IV

Effect of Phosphate on *S. marcescens* and *B. Subtilis*

Organism	Source of carbon	Concentration of phosphate	Carbon source consumed in gm.	Butylene glycol formed in gms.	Percentage yield on the basis of consumption
		Per cent			
S. marcescens	Starch	0·15	0·98	0·085	8·67
		0·30	0·98	0·048	4·89
		0·45	1·11	0·016	1.44
	Cane sugar	0·15	...	0·178	...
		0·30	0·18	0·38	..
		0·45	1·67	0·255	15·27
B. subtilis ...	Starch	0·15	2·68	0·053	1·98
		0·30	2·49	0·057	2·3
		0·45	2·74	0·020	0·73
	Cane sugar	0.15	1·81	0·481	26·6
		0·30	1·26	0.4 5	38·5
		0·45	2·58	0·388	15·04

The cultures originally contained—source of carbon 3 per cent, ammonium sulphate—0·17 per cent, $MgSO_4$ 0·08 per cent.
Period—35 days.

TABLE V

Comparative Study

Organism	Cane sugar and 0·15 per cent phosphate		Starch and 0·3 per cent phosphate		Cane sugar and 0·3 per cent phosphate		Effect of milk with cane sugar and 3 per cent phosphate	
	Butanediol in gm.	Butanediol per cent on sugar consumption.	Butanediol in gm.	Per cent yield on starch consumption.	Butanediol in gm.	Per cent yield on sugar consumption	Butanediol in gm	Per cent yield on sugar consumption
1. *Pseudo monas hydro phila.*	0·162	36·0	0·004	Less than 1 per cent	0·26	18·6	0·093	3·4
2. *Aerobacter Aerogenes* M-148.	0·113	22·6	0·004		0·073	3·99	0057	47·5
3. *A. Aerogenes* 474	0·162	27·5	0·004		0·24	15·2	0·154	5·86
4. *B. Polymyxa* C-32.	0·101	20·2	0·339	18·9	0·093	5·1	0·057	
5. *B. Subtilis* B-2.	0·283	29·8	0·315	13·1	0· 01	7·1	7·1	Negligible

Organism	Cane sugar and 0·15 per cent phosphate		Starch and 3·3 per cent phosphate		Cane sugar and 0·4 cent phosphate		Effect of milk, cane sugar and 2 per cent phosphate	
	Butanediol in gm.	Butanediol per cent sugar consumption	Butanediol in gm,	Per cent yield on starch consumption	Butanediol in gm.	Per cent yield on sugar consumption	Butandiol in gm.	Per cent yield on sugar consumption
6. S-29 *S. marcescens.*	0·04	8·0	0·145	6·1	...	..	0·036	1·93
7. *B. subtilis* ...	0.222	44·4	0·004	Less than 1 per cent	0·43	27·6	0·154	31·3
8. *S. marcescens* Poona	0·19	26·0	0·004		0·25	33·3	0·036	27·7
9. *B. subtilis.* ..	0·295	32·1	0·004		0·37	88·0	0·17	7·05
10. *S. marcescens*	0.109	68·1	0·004		0·012	4	0·093	16·6
11. *A. aerogenes* (Indol neg.)	0·15	68·7	0·004		0·13	26	0.077	5·03

[The cultures contained—carbon source—3 per cent. $MgSO_4$—0·08 per cent $(NH_4)_2 SO_4$—0·17 per cent—Period—30 days].

TABLE VI

Effect of $ZnSO_4$ on *B. Subtilis*.

Source of carbon	Concentration of $ZnSO_4$	Total sugar or starch consumed	Butanediol formed in gm.	Percentage butanediol on the basis of sugar or starch consumed
Cane sugar	Nil	2·44	0·097	3·98
	0·01	1·46	0·289	19·8
	0·02	1·36	0·363	26·7
	0·03	2·13	0·225	10·6
Starch ...	0·01	3	0·020	0·67
	0.02	3	0·024	0·80
	0·03	3	0·004	0·13

The cultures originally contained—Source of carbon 3 per cent—$MgSO_4$—0·08 per cent, $(NH_4)_2SO_4$—0·17 per cent., Phosphate 0·15 per cent. Period of fermentation—30 days.

TABLE VII

2, 3 Butanediol fermentation using molasses

Name of organism	Sugar consumed in gm.	Butanediol formed in gm.	Per cent yield of butanediol on the basis of sugar consumed	The cultures originally contained—molasses sugar concentration—10·2 per cent. Period of fermentation —2 months.
Aerobacter aerogenes M 148.	3·22	0·059	1·89	
A. aerogenes. 474.	2·44	0·044	1·80	
B. polymyxa C-32.	9·62	0·011	0·11	
B. subtilis B-29	7·72	0·014	0·18	
S. marcescens S-29.	3·2	0·13	3·97	

Inference—Our experiments indicate that *S. marcescens* can be used for 2, 3 butanediol fermentation with sugar substrate and a good yield of 80 per cent is obtained even at the concentration of 12 per cent. *B. subtilis* gives good results only with sucrose and not with starch. The chief difficulty with this organism is that the yield of diol decreases with the increase of concentration.

Milk has found to increase the butanediol fermentation in the case of *S. marcescens*, on sugar substrates even when very small percentage of milk is used.

Calcium carbonate has been found to have an adverse effect on the butanediol fermentation in the case of *B. subtilis* and *S. marcescens*.

It has been observed that the increase of phosphate in the cultures decreases the formation of 2, 3 butanediol. 0·3 per cent concentration of phosphate has been found to be optimum for the formation of butanediol by *B. subtilis*.

It has been observed that *B. subtilis*, *S. marcescens*, *A. aerogenes*, *Pseudomonas hydrophila* and *B. polymyxa* can profitably be used for 2, 3 butanediol fermentation and at the concentration of 0·15 per cent phosphate, *S. marcescens* and *A. aerogenes* are the best diol producing organisms.

Starch can be utilised only by *B. polymyxa* for producing 2, 3 butanediol and not by other organisms.

Increased quantity of phosphate (0·3 per cent) decreases the yield of diol in almost all the organisms except *B. subtilis* in which case it is the optimum concentration of phosphate for the formation of diol whose yield reaches as high as 88 per cent.

Milk has been found to favour the diol formation only in the case of *S. marcescens* and that too only when the concentration of phosphate is low in the culture.

Addition of a small quantity of $ZnSO_4$ increases the formation of butanediol appreciably in the case of *B. subtilis* when sugar is employed as substrate. Thus all the conditions being similar, the ratio of butanediol formation in cultures containing no $ZnSO_4$ to culture containing 0·02 per cent of $ZnSO_4$ is 3·98—26·7. However, this $ZnSO_4$ does not help the formation of diol when starch is the substrate.

The study of the formation of 2, 3 butanediol using molasses has shown that the two strains of *A. aerogenes* and *S. marcescens* can be used with advantage for its production. However, the percentage yield with molasses is very poor and we are studying the conditions under which this yield can be increased.

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APPLIED AND INDUSTRIAL

1. *Research Workers*—Dr. B. Mukerjee, and Km. Shail Kumari Sharma, Central Drug Research Institute, Lucknow.

Research Project—Colourization of Vanaspati.

The objective is to find out a suitable colouring agent which will colour vegetable hydrogenated fat (Vanaspati) to render this distinguishable from natural ghee. The colouring matter must satisfy the following conditions :

(1) Be nutritionally non-injurious to health ;

(2) Giving pleasing appearance and taste ;

(3) Be stable and not easily destroyed or removed by heating, aeration, absorption by wood and animal charcoal activated or otherwise or by Fuller's earth and exposure to direct sunlight ; and

(4) Be detectable by chemical methods.

After careful consideration, the following colouring materials have been tried :

(1) Annato (Bixa orellana) seed dye ;

(2) Alkanet Anachus tinctoria) root dye ;

(3) Chlorophyll ;

(4) β-Carotene (Synthetic) ;

(5) Fettorange ;

(6) Ratanjot (Onosma echoides) root dye.

The work done on these are enumerated below :

Annato— 0·1 per cent. of the powdered Annato seed was used for the colouration of hydrogenated vegetable fat (Vanaspati). The colour obtained was orange. This colour, however, was completely removed on boiling. A higher concentration of the powdered root, up to the extent of 40 per cent. was tried. The colour obtained was bright orange. But even with this concentration, the colour faded almost to faint yellow on boiling. This faint yellow colour resembled very much that of pure ghee. As the colour was found to be easily removed by ordinary means, such as boiling, the dye was considered unsuitable for the purpose of detection of adulteration.

Alkanet—The powdered root of the drug gives a red colour to Vanaspati. Samples of Vanaspati coloured with 0·02, 0·05 and 0·07 of powdered root of the drug, giving adequate colour intensity, were subjected to boiling for an hour. On a qualitative visual estimation it was found that the colours in each case faded only slightly. The same mixtures on treatment with activated charcoal showed a considerable loss in their colour intensity but on treatment with Fuller's earth the colour was removed completely from all the samples. Even when

samplee of Vanaspati coloured with 0·2 per cent of the powdered drug giving a deep red colour was treated with Fuller's earth, the colour was completely lost. This dye, therefore, was not taken up for further investigation.

Chlorophyll—Powdered dried leaves of *Spinacia oleracea* Linn. (Palak) when heated with Vanaspati gives a beautiful green colour. The colour obtained by using 0·2 per cent of the dried leaves was of sufficiently high intensity and did not show an appreciable fading on boiling, but the colour was completely removed on treatment with common adsorbent like activated charcoal. In view of this it was considered unsuitable for the colourization of Vanaspati.

β-Carotene—β-Carotene gives a deep orange colour to Vanaspati. This colour, however, has been found to be completely removed by reagents like activated charcoal and Fuller's earth even in concentration up to 0·4 per cent of synthetic β-carotene at which level the colour was sufficiently deep. This agent was, therefore, considered unsuitable for the purpose.

Fettorange—Fettorange (1, 3, dioxybenzol) is used as food colour in Egypt, Sweden, Switzerland, Poland, Rumania, Turkey, etc. A deep yellow colour was imparted to Vanaspati when 0·05 per cent of the dye was used. On further increasing the amount of the dye (0·08) a light orange colour was obtained. Qualitative estimation regarding the stability of the dye against boiling, aeration, ultra-violet irradiation and on treating with common adsorbents, such as Fuller's earth and activated charcoal, show that it is fairly satisfactory for practical purposes. Quantitative estimations, as well as to find out its suitability as a colouring agent for the detection of adulteration in ghee either singly or admixture with other dyes are in progress.

Orange SS and Oil Red XO—Originally it was proposed that physiological investigations and toxicity tests with regard to two dyes namely Orange SS and Oil Red XO should be undertaken in the present scheme. But since a report from the U. S. Food and Drugs Administration has indicated them as definitely toxic and Allmark and co-workers have also found them to be toxic. Further investigations with these dyes was thought not worth undertaking.

Ratanjot—The roots of Ratanjot are easily available in the market and are sold as colouring agents for foodstuff. It is quite cheap selling at 3 as. per chhatak (approximately 56 gms.) Its powdered root when heated with Vanaspati gives a red colour. The colour was considerably removed on treatment with common adsorbents in lower concentration, but in concentration over 0·3 per cent, the loss on such treatment was comparatively less. Samples of Vanaspati coloured with 0·1, 0·2, 0·3, 0·4 and 0·5 per cent of the material were prepared and it was found that 10 per cent of adulteration in ghee could be detected even on visual examination when samples coloured with 0·3 per cent and above of the material were used as the adulterant. (As the original coloured samples of Vanaspati were very deep, it was not possible to get the reading on the scale of the instrument. Hence, while taking colorimetric measurements each samples was diluted 10 times with pure Vanaspati. On diluting 10 times the coloured sample of Vanaspati containing 0·3 per cent of Ratanjot, the optical density was 0·126).

To study the stability of the colouring matter of Ratanjot against physical and chemical treatments, detailed quantitative estimations were made and percentage loss in the colour intensity on such treatments of each coloured samples were determined. It has been found that the above coloured samples when exposed to ultra-violet irradiation for one hour did not show any appreciable loss in their colour intensity. On passing air through the boiling samples of the coloured Vanaspati for 5 hours certain loss in the colour intensity was observed which decreased with the increase in the concentration of the powdered drug. On simple boiling for a prolonged period, the loss in the colour intensity ranged from 20—50 per cent. On keeping in the laboratory under normal conditions practically no change in the intensity of the colour in any of the samples has been observed even after a period of three months.

Considering the colour intensity and reactions to physical and chemical treatments, the samples of Vanaspati coloured with 0·3 and 0·4 per cent of the material were found suitable for the use of detection of adulteration in ghee. These two samples, however, when treated with activated charcoal (as high as 30 per cent of the coloured Vanaspati by weight) gave a loss of colour intensity nearly 69-72 per cent and with the Fuller's earth (in same concentration) the loss was 54 per cent However, in spite of considerable loss in colour on treatment with the adsorbants it has been found that the colour remaining in either of these samples was sufficient to detect their presence in ghee in 15 per cent and above.

Physiological Investigation.—Five groups of albino rats (each group weighing between 30—40 gms.), each group consisting of one male and three females were taken and kept separately. In one group, serving as the control, each rat was given daily oral dose of 0·2 c. c. of pure Vanaspati. Each animal of the 2nd and 3rd group was fed daily with an oral dose of 0·2 c.c. of Vanaspati coloured with Ratanjot in the proportion of 0·3 per cent. The animals of the 4th and 5th groups were each fed with a daily oral dose of 0·2 c.c. of Vanaspati coloured with 0.4 per cent of Ratanjot. The daily dose of 0·2 c.c. of Vanaspati was ascertained roughly on the basis of an average consumption of ½ chhatak of ghee.

2. *Research Workers*—Dr. P.P. Rao and Sri P.S. Balaraman Naidu Forest Research Institute, Dehra Dun.

Research Project—Preparation of Chlorophyllins and testing them for their deodorant activity *in vitro*.

Copper chlorophyll, as obtained by Forest Research Institute patent method, has been improved upon to yield better product of higher tinctorial value. Water soluble copper chlorophyll was prepared by a method developed in this laboratory.

Copper chlorophyll of high tinctorial value has been obtained according to an improved method developed in this laboratory.

With a view to finding out whether hot extraction of the leaf powder by completely covering it with alcohol would yield copper chlorophyll of better quality than that obtained by the method of extraction in a copper soxhlet, the leaf powder was covered with alcohol in round-bottom flask and the contents refluxed for six hours to obtain the extract. It has been observed that there is no difference either in the yield or in the quality of the product obtained by these two methods.

As originally planned, 100 gms. of water soluble chlorophyll has been prepared during the period under report. The final active water soluble chlorophyll has also been purified by washing it with hexane.

3. *Research Workers*—Dr. D. R. Dhingra and co-workers, Harcourt Butler Technological Institute, Kanpur.

Research Project—Study of the development of chemical constituents of essential oil bearing plants—of vetiver plants grown at Kanpur.

Considerable quantities of vetiver roots are available in various parts of the country specially Rajasthan, Uttar Pradesh and Kerala where they are distilled for the recovery of the oil. Vetiver oil is used mainly in perfumery, cosmetics and soap industry. The major part of the oil is distilled in North India from the roots of self-grown plants except at Kerala (Travancore-Cochin), where the cultivation of vetiver is carried out (nearly 500 acres). The quality of the oils produced from North Indian roots is not uniform and varies from place to place depending upon the climatic and soil condition and also on the maturity of the plants extracted.

The aims of the scheme are :—

(1) to cultivate vetiver roots from important vetiver oil producing regions of the country in the fields;

(2) to determine the oil content in the roots extracted therefrom at various stages of growth;

(3) to study the characterstic properties of the oils so obtained and

(4) to determine the optimum maturity period required for the maximum yield of oil for each variety;

Progress achieved so far—Vetiver slips received from Bharatpur Math (Mathura), Kaurialaghat (Lakhimpur Kheri), Musanagar (Kanpur) and Travancore were cultivated in the Institute gardens and extracted after a maturity of 6—8 months, 12 months, 18 months, 24 months and 30 months. They were examined for their oil contents. The oils distilled from them by water and steam distillation method were studied for their physicochemical properties. The data obtained are given in the following tables :

Comparative statement of the yield of oil in vetiver roots of different places at different maturity periods

Percentage of oil in vetiver roots after a maturity of

Roots from	8 months	12 months	18 months	24 months	30 months
(1) Bharatpur—oven dried stems.	...	...	0·983	1·041	1·06
(2) Math—Oven dried stems.	0·62	0·84	1·08	1·33	...
(3) Kaurialaghat—Oven dried stems.	...	...	1·43	1·68	1·77
(4) Musanagar—Oven dried stems.	0·28	0·38	0·55	0·72	0·78
(5) Travancore—Oven dried stems.	...	...	1·77	2·28	...

Physico-chemical properties of vetiver oils from vetiver roots of different places distilled at various maturity periods.

Vetiver oils distilled from the roots of	Sp. gr. at 30°C	R. I. at 30°C	Opt. rot.	Acid value	Ester value	Ester value after acetylation	Alcohols as $C_{15}H_{25}O$ per cent		Total alcohols per cent	Solubility in 80 per cent alcohol
							Free	Combined		
Bharatpur—18 months ...	0·9980	1·5220	—81°12′	10·37	31·81	193·6	72·28	12·44	84·72	1-2 vols.
24 months ...	0·9986	1·5230	—83°36′	9·2	32·51	196·7	73·55	12·77	86·32	Do.
30 months ...	0·9998	1·5234	—84°36′	8·2	33·5	197·8	73·61	13·15	86·76	Do.
Math—8 months ...	0·9949	1·5151	—96°6′	38·2	11·0	193·5	83·01	4·32	87·33	Do.
12 months ...	0·9969	1·5170	...	11·2	21·3	203·9	83·11	8·36	91·47	Do.
18 months ...	0·9982	1·5180	—118°36′	8·75	22·54	201·6	81·39	8·85	90·24	Do
24 months ...	0·9994	1·5186	—126°	6·45	25·08	206·0	82·23	10·04	92·27	Do.
Kaurialaghat—18 months	1·0120	1·5200	—109°48′	31·7	43·4	182·3	60·91	17·04	77·95	Do.
24 months	1·0150	1·5180	—118°	26·8	45·02	182·6	60·26	17·68	77·94	Do.
30 months	1·0148	1·5184	119°12′	25·8	45·8	183·5	60·32	17·99	78·31	Do.

Mysore—8 months ...	1·0140	1·5114	—29°24′	39·4	43·2	171·2	55·68	16·97	72·65	1-2 vols.
12 months ...	1·0032	1·5141	—38°30′	50 97	44·54	185·3	61·9	17 5	79·4	Do.
18 months ...	1·0150	1·5150	—42°6′	32·1	46·36	187·1	61·81	18 12	79·93	Do.
24 months ...	1 0300	1·5200	—50°12′	30·26	45·36	188·8	63·14	17·72	80·85	Do.
30 months ...	1·0310	1 5210	—53°18′	30·8	46·2	189·2	62 92	18 14	81·06	Do.
Travancore—18 months ..	1·010	1·5250	+42°24′	8·5	25·02	162 8	55·50	13·77	69·27	Do.
24 months ..	1·015	1·5250	+46°24′	6·4	38·8	166·1	55·15	15·24	70·39	Do.

It may be observed from the above tables that the percentage of oil (based on oven dried stems), the length of rootstems and the weight of roots per plant go on increasing with maturity in almost all cases. In North Indian vetiver roots, there is an appreciable rise in oil content up to 24 months, maturity, whereas the optimum maturity period for the Travancore root is about 12 months, after which the increase in the oil content is not much. It would, therefore, be economical to extract the north Indian roots after a maturity of 22 months (because the increase in the oil content in roots after 30 months maturity is very little) and the Travancore variety roots after a year.

It may also be observed that the oil content in Travancore roots is about double to those of Bharatpur and Math roots while it is about 1½ times to that of Kaurialaghat roots. The Musanagar variety, however, contains the minimum amount of oil, though the quality of this oil is considered to be the best of all by the perfumers.

As regards the physicochemical properties, the specific gravity, ester value before and after acetylation go on increasing while the acid value and optical rotation (in north Indian oil) go on decreasing with the maturity of the roots. These changes are appreciable up to a maturity of 12 months, after which the alterations are slight.

The total alcohol contents in oils from Travancore and Kaurialaghat roots are less than those of Math, Bharatpur and Musanagar variety oils. The Musanagar variety oils contain a much higher acid value and, therefore, the oils are generally greeny, if the distillation equipment is not properly tinned while other oils are brownish in colour.

Preparation of the concrete—The Travancore variety root stems were extracted with purified benzene to prepare their concrete. The concrete obtained (yield 4·06 per cent) was extracted with alcohol at low temperatures and its absolute prepared. The yield of the absolute was 3·91 per cent whereas the yield of oil by distillation of the same roots is 1·78 per cent. The concrete was analysed for its physicochemical properties which are as follows :

Sp. gr. at 30°C	1·0315
Ref. index at 30°C	1·5201
Opt. rotation	33°36′
Acid value	53·6
Ester value	17·7
E. V. after acetylation	193·6
Total alcohols as vetiver oil	86·6 per cent.

Estimation of carbonyl compound in vetiver oils—Modified, method for the estimation of carbonyl compounds (I. S. I. bulletin 1956, Vol. 8, no. 5) was followed for a number of samples of vetiver oils. The results are given in the table below. The ketones were also

estimated in the same vetiver oil samples by B. P. method using dimethyl yellow as an indicator. The results are given below in the table :

	Per cent Ketones by modified method	B. P. method using dimethyl yellow as indicator
	per cent	Per cent
Biswan	23·80	21·32
Kaurialaghat	34·50	34·31
Math	36·80	...
Bharatpur	28·35	..
Dholpur	23·31	...
Travancore	18·43	...

In both the methods the end point is quite sharp in the case of light coloured oils but in the case of dark coloured oils there is some difficulty in getting the end point correctly.

In the above methods, no consideration is made for the acids present in the oils and as vetiver oils have sufficiently high acidity, therefore, the methods give higher values for the ketone content.

If the correction is applied for the acids present on the samples examined above the ketone content will be reduced to as given below :

	Per cent
Biswan	19·72
Kaurialaghat	31·44
Bharatpur	23·8
Travancore	14·29

Further experiments are in progress using electrical titration method.

4. *Research Workers*—Dr. D. R. Dhingra and Sri M. C. Nigam, Harcourt Butler Technological Institute, Kanpur.

Research Project—Development of rose oil industry in India.:

Experiments were conducted for determining the optimum conditions of distillation by maintaining different names of distillation and estimating the yield of oil in them on the weight of fresh flowers (Rose Edward only). It was observed that if the distillate amounting to 60 per cent

on the weight of flowers is collected in the first hour (excluding the time required for heating) the amount of the oil obtained is 0·0115-0·0118 per cent, while if the distillate collected is less, the yield is lower. The Bulgaria distillation is done for 1½ hours and the distillate collected is 56 per cent on the weight of fresh flowers. Solvent extraction of flowers using benzene was tried and the concretes obtained were analysed and the percentage of steam volatile constituents in them were determined.

Experiments were made to prepare the absolute from the concretes and the yield of absolute in the case of Rosa damascena flowers was found to be 0·06 per cent on the weight of fresh flowers. The oils obtained by distillation of Rose Edward and Rosa damascena flowers were examined.

Details of the present progress report—Further experiments were made to prepare the concretes from different variety of roses viz., Rose Damascena, Rose Edward and Rose teplitz using petroleum ether instead of benzene which had so far been used. The yield of the concretes obtained is as follows :

	Per cent
Rose damascena	0·17 to 0·18
Rose Edward	0·14 to 0·15
Rose teplitz	0·11 to 0·12

The above concretes have also been examined. Their physico-chemical properties are given below :

	Rose damascena	Rose Edward	Rose teplitz
M. P.	51°C	58°C	57°C
C. P.	48°C	54°C	53°C
A. V.	8·6	7·9	4·5
Sap. value	22·1	49·3	39·0

Experiments are in progress to determine the percentages of absolute and steam volatile constituents in the above concretes.

Semi-large scale experiments were conducted to prepare the rose oil at Hassayan during the month of March and April to verify the results obtained at Kanpur previously. The process employed is given below :

One maund of rose flowers and two maunds of water were fed in a country still which was heated slowly by direct fire (dried cow dung cakes). The heat was so regulated that the distillation started after 1½ hours. The distillate was collected for 1½ hours

during which time about 5 gallons of distillate (first water) was collected. Another 5 gallons of distillate (second water) was also collected during a period of next 1½ hours. The first and second waters were kept separately. The second waters were used with fresh flowers and the first waters were further concentrated by distillation to 1/8th of their volume. The latter distillate was cooled and the oil was separated. The rose water after the separation of oil was mixed with first waters and the residual water in the still was used with the fresh lot of flowers along with the second waters.

Ten maunds of rose flowers were distilled by the above process and the yield of the oil was 0·02—0·24 per cent on the weight of flowers.

It may be seen that the yield from Indian rose flowers (Rosa damascena) is slightly less than that obtained in Bulgaria which may be attributed to the climatic conditions of the country.

To determine the keeping quality of flowers, some experiments were made to determine the oil content in the rose flowers which had been kept in the shade at room temperature for a period of four hours. It was observed that the temperature had risen by 2°C, 3°C and 4°C and when the thickness of the layer of flowers was 5", 6" and 7", respectively. The average percentage of oil in three types of rose flowers after keeping was as follows. It may be stated that the distillates were treated with solvents to extract the rose oil. The room temperature was 36°C :

Name of flower	Yield after keeping for four hours	Normal yield from fresh flowers
	Per cent	Per cent
Rose damascena	0·01145	0·020 to ·022
Rose teplitz	0·01098	0·013 to ·015
Rose Edward	0·00428	0·011 to ·013

Another set of experiments was made by spreading the flowers on the cemented floor for four hours and spraying water over them to keep them moist. The rise in temperature was 1°C, 1·5°C and 2°C when

the thickness was 7", 8" and 9" respectively. The percentage yield of oil from different types of flowers was as follows :

Name of flower	Yield after keeping for four hours	Normal yield of fresh flowers
	Per cent	Per cent
Rosa damascena	·01213	0·02 to 0·022
Rose teplitz	·01125	0·013 to 0·015
Rose Edward	·00612	0·011 to 0·013

It may thus be seen that the loss of oil was less in the latter case when the flowers were kept moist.

Further experiments to minimise the loss are in progress. They include :

(i) Preservation of flowers under refrigeration.
(ii) In salt water of various concentration.

The table below gives the results of analysis of rose oils prepared from Rosa damascena, Rose Edward and Rose teplitz flowers by water and steam distillation method :

Analysis of samples of Rose Oils

—	Rosa damascena, Hassayan.	R. damascena, Kanpur	R. damascena oil, Kanpur (Rose Water)	R. teplitz, Kanpur	R. teplitz Rose water oil	Rose Edward Rose water oil
1. Sp. Gr. at 80°C	0·8814	0·8845	0·9386	0·8842	0·9288	0·9408
2. Ref. index at 80°C.	1·4657	1·4657	1·4877	1·4662	1·4817	1·4092
3. Opt. rotation	—4·6°	—2·5°	—5·5°	—3·6	—1·1°	—3·9°
4. Acid value ..	2·6	2·6	5·6	1·9	4·08	6·8
5. Ester value ..	19·48	18·7	18·0	13·8	20·77	27·8
6. Sap. value ..	22·08	21·3	23·6	15·7	24·8	34·1
7 S. V. after acetylation.	231·2	264·6	267·6	265·08	275·8	272·9
8. Total alcohol as geraniol.	68·05%	81·6%	81·9%	84·3%	84·8%	77·6%
9. Citronellol by formylation.	31·4%	35·9%	51·6%	32·8%	..	56·6%
10. Congealing point	17·5°C	18—19°C	24°C	16°C	13—14°C	20—21°C

Manurial experiments have been started using farmyard, ammonium sulphate, nitrate alone and in combination. Superphosphate could not be tried as it was received very late. Cross breeding of Rose Edward and Rose teplitz with Rosa damascena has been done during this period and the results are awaited.

Work carried out at the National Botanical Gardens, Lucknow on the Scheme "Development of Rose Oil in India"

As stated in the previous report the pot-cultured rose varieties added with manures—castor cake and bone meal were kept under constant observation during all the winter days and latter with the onset of summer. The main interest was to note as to how these varieties respond to the added amount of castor cake and bone meal on its capacity and intensity of flowering, the typical characteristics of the individual blooming in comparision with their previous descriptions, the effects on fragrance and also the period of withholding fragrance, etc.

In this connection it can be said that the mixture composition of castor cake and bone meal added to the plants is very suitable for their all sided growth, but more so of green leafy matter and branching habits. The intensity of blooming also changes appreciably and also the number of blooms at a time per plant also shows a marked increase.

Secondly, the flowering period is lengthened in two ways. Firstly, after addition of manure within 15 days it shows good signs of growth and bud formation. The flowering starts soon though for number of varieties it may mean an early flowering stage. Secondly, the flowering with vigour continues till the end of April and thus the period shows an increase.

With regard to individual blooms, it was observed that the size, shape and fragrance as also the colour give out a definite change effected by the manures. The size of the flowers showed a characteristic increase up to 3" that the normal size of the particular variety, as noted previously. Shape and form also show distinctly the vigour and toughness of the flower parts; colour of the petals is deeper in the same strain and more resistant to bright sunlight. Fragrance is obviously enhanced, not only that but the capacity to withhold the fragrance reaches up to 5 days even if the flower is in full bloom. Size of the petals is enlarged but very little or negligible change in the number of petals per flower. Except some 15 varieties which showed an increase in the number of petals from 8 to 12 and some other varieties in which the size of the petals is just doubled the rest do not give much appreciable or obviously observable change.

With the onset of summer the pots were in the same condition as previously and they showed effects due to summer in less or non-flowering, dried and shrivelled look of the plants.

At this time, i.e., 10th of May, the place where the pots were kept, was covered up by palm leaves and thus the plants were shaded and watering was done twice a day and again it showed signs of good healthy plants and some of the plants gave flower though, of course, the flowers were small in size with little or devoid of fragrance and chromatic aberrations.

The amount of manure added per pot of 12" is as stated : 6 ozs. of castor cake, 8 ozs. of bone meal. Manuring was done in early October.

The same experiment was carried out on Rose Edward on a plot of 20 plants only, and the results noted above for other varieties were also observed in this case. The only difference being that the size and shape of flowers were not too much changed, but definite enhancement of fragrance was noticeable. Another interesting effect was of profuse branching and so, along with this more flowering.

Some fragrant varieties were crossed for hybridization and production of new varieties the results of which are not yet mentionable.

During the months of July and November the leaves of the rose plants were attacked by black spot and red rust diseases. At first pyrenox was sprayed thrice a week. The disease did not spread but was not completely under control. But no sooner manure was added to the pots and also pyrenox sprayed thrice a week the disease completely disappeared.

5. *Research Workers*—Dr. Sadgopal and Sri B. C. Gulati, Forest Research Institute, Dehra Dun.

Research Projects—Chemical examination of the essential oil of valerian from the valeria species.

For the chemical study of the essential oil from the roots of *Valeriana wallichii* DC., their samples were acquired from the following forest divisions—(i) Ram Ban (Jammu and Kashmir State), (ii) Baramulla (Jammu and Kashmir State), (iii) Chamba (Himachal Pradesh), (iv) Chakrata (Uttar Pradesh), (v) Rajgarh (District Sirmoor, Himachal Pradesh), and (vi) Kot Garh (Himachal Pradesh).

After the botanical identification and confirmation of the relative plant material by the Systematic Botanist at the Forest Research Institute the roots were subjected to their examination for—(i) moisture content, (ii) alkaloidal content, (iii) ash content, and (iv) essential oil content.

It was noted during steam distillation of the roots that in some cases, a small amount of the oil sank to the bottom of the copper Florentines and in other cases appreciable quantities of the oil remained suspended in the condensate. The lighter and heavier oils were recovered separately and their physicochemical properties studied.

Considerable quantities of water condensate were collected as it was found that appreciable amount of water-soluble lower fatty acids were being carried away along with the distillate even when freed from oil. An examination of water soluble constituents from about 100 lb. of the oil-free condensate revealed the presence of acetic and formic acids. Fractionation of the acids at atmospheric pressure and their further examination confirmed the presence of iso-valeric acid.

The different samples of the oil distilled from the roots in the distillery as well as in the laboratory were separately subjected to their complete physicochemical examination.

It was found that oils obtained from the roots from Chakrata, Raj-Garh and Kotgarh areas are dextro-rotatory; while the same obtained from Ramban, Baramulla and Chamba areas are laevo-rotatory. No dextro-rotatory oils have been reported from the European and Japanese valerian roots. This aspect is further under investigation.

The details given below concern a sample of the *l*-valerian oil from Chamba and Ramban, fractionated at 10 mm :

From the low boiling fraction *l* up to 135/175 mm. a mixture of acids and carbonyl compounds was separated chemically and identified.

The fraction *l* 120-142/10 mm. were a mixture of close-boiling sesquiterpenes which could not be separated.

The fraction *l* 142-154/10 mm. were a mixture of sesquiterpenes and oxygenated compounds.

The fraction *l* 154/10 m.m. on chemical treatment and refractionation gave a new tricyclic sesquiterpene (90 per cent) which is under study.

The solid m. 107°C from *d*-valerian oil on dehydrogenation gave a compound which is indicated to be eudalene.

The essential oil distilled from various samples of valerian roots was examined as well as the oil-free distillate for its water soluble constituents. A chromatographic process was developed for the identification of the lower fatty acids.

After completing the study of *l*-valerian oil, dextro-valerian oil was taken up for the detailed examination. Roots were obtained from Chakrata. The essential oil was obtained by steam distillation in distillery as well as by extraction with rectified spirit in a solvent extraction. The oil obtained by these two methods was studied for their physicochemical properties.

The new sesquiterpene was examined further. The solid m. 107°C was also subjected to a few reactions.

6. *Research Workers*—Dr. Sadgopal and Sri S. A. Narang, Forest Research Institute, Dehra Dun.

Research Project—Study of the new sources of drying fatty oils from the seeds of the indigenous plants of Euphorbiaceae family.

The component glyceride structure of stillingia oil was determined by the methods mentioned in last report and it has been calculated to contain disaturated mono-linoleo (7·9 per cent), mono-saturated-dilinole (7·92 per cent), mono-oleo-dilinoleo (6·0 per cent), mono-linoleo-dilinoleo (45·7 per cent), mono-linoleo-dilinoleo (10·6 per cent), mono-oleo-dilinoleo (3·3 per cent) and oleo-linoleo- linoleo glycerides (18·4 per cent).

(ii) The sample of the stillingia oil showed an optical rotation of —5·76° in (100 mm) tube and the oil on complete hydrogenation in the presence of nickel catalyst suspended on Kieselguhr showed no optical rotation property of stillingia oil which may be due to the presence of

18·40 per cent oleo-linoleo-linolene glyceride (an asymmetric glyceride) which has been calculated to be present in the component glycerides of the oil but this constituent could not be isolated from the oil in a free state.

(iii) The component fatty acids of the stillingia tallow from the fruit-coat of *Sapium sebiferum* Roxb. were determined by the usual method of leadsalt separation, ester formation, and vacuum fractional distillation of the methyl esters of solid and liquid acids. It has been found to contain lauric acid (0·27 per cent), myristic (4·2 per cent), palmitic (64·89 per cent) (major component), stearic acid (5·83 per cent) and oleic acid (25·81 per cent).

(iv) The component glyceridic structure of the stillingia tallow has been determined by low temperature crystallisation method. It has been found to contain the glycerides of tripalmito (16·58 per cent), dipalmito-mono-stearo (7·39 per cent), dipalmito-mono-myristo (3·11 per cent), dipalmito-mono-oleo (64·05 per cent), dimyristo-mono palmito (0·6 per cent), distearo-mono myristo (3·3 per cent) and mono-palmito-dioleo (4·84 per cent).

(v) A new oil from the seeds of *Buxus semiperverin* Linn. obtained from Palampur (Kangra-Punjab) has been obtained which for convenience, may be named as "Buxus Oil". The seeds have been found to contain (34 per cent) of this oil by using petroleum ether (40—60°C) and sulphuric ether as extracting solvents separately and it has been examined for its physico-chemical characteristics.

7. *Research Workers*—Dr. Sadgopal and Sri N. L. Zutshi, Forest Research Institute, Dehra Dun.

Research Project—Chemical examination of the essential oil of vetiver and methods of estimating its important constituents.

The details given below concern a sample of vetiver oil (Bharatpur) fractionated first through a Towers' and then an Emile Greiner's column.

Solid m. p. 87°C obtained from the fractions $bp._{10}$ 158—162°C was found to be a sesquiterpene alcohol of molecular formula $C_{15}H_{24}O$. This gives a crystalline hydrochloride and a bromide and on dehydrogenation gives a copius yield of cadalene.

Solid m. p. 101°C obtained by congealing fraction b.p. 145-162°C was found to be a sesquiterpene primary alcohol of molecular formula $C_{15}H_{24}O$. It is unsaturated in nature.

By phosphoric acid treatment of the fractions b.p. 165-172°C, a small amount of blue coloured azulene was isolated, which was insufficient for its identification.

Residue (23 per cent of the whole oil) gave much trouble in its urification. Partial crystallisation and other chemical methods of rification failed to isolate the components of the mixture that the resi-ue is. Elution through an alumina column gave some satisfactory results. On dehydrogenation it gave a liquid, which is yet to be exa-mined.

Highly viscous liquid (b. p. 145-260°C), on saponification gave a mixture of steam-volatile and steam non-volatile acids together with a mixture of alcohols. The residual highly viscous oil on distillation gave a solid, m. p. 135°C (crude).

Some of the details of the above chemistry are appearing in "*Perfumerry and Essential Oil Record*" under the heading "Fractionation of Indian Vetiver (Khus) Oil" and further work on these important fractions is in progress.

8. *Research Workers*—Dr. Sadgopal and Sri N. L. Zutshi, Forest Research Institute, Debra Dun.

Research Project—Sesquiterpenes from Indian vetiver (Khus) oil. Isolation of 'Khusone', 'Cussol', 'Khusol', 'Khusenic Acid' and 'Khusene'.

The results have been published in "Perfumery and Essential Oil Record", London July, 1957.

(1) The sesquiterpenes of the Indian vetiver (khus) oil have been characterised.

(2) The oil has been found to contain bi-and tricyclic vetivenes, bi-and tricyclic vetiverols, β-vetivone, etc., as the known constituents.

(3) The oil contains two solid sesquiterpene alcohols, one sesquiterpene ketone, one diterpene and one sesquiterpene acid as the unknown constituents, which have now been characterised and tentatively named by us.

9. *Research Workers*—Sri Om Prakash, Sri A. C. Gupta, Sri V. D. Athawale, Sri S. C. Pandey and Sri Atma Ram, Harcourt Butler Technological Institute, Kanpur.

Research Project—Isomerisation of linseed oil.

Papers published—

(1) Isomerisation of linseed oil, *Paint-India*, vol. 5, no. 12 p. 21—25.

(2) Isomerisation of linseed oil by iodine, *Proceedings and Journal of the Oil Technologists' Association*, India, Kanpur, 1956, p. 19.

Isomerisation of linseed oil with the use of iodine as catalyst has been studied. Optimum conditions for obtaining a product with high conjugation have been found as described below :

One per cent of iodine at a temperature 200°C and time of reaction one and half hours has been found to produce conjugation corresponding to a maleic anhydride value of about 23. Also use of 1 per cent iodine and boiling with toluene under reflux for three hours has been found to give similar products. Comparative tests as regards varnish making properties isomerised oil against linseed oil have been carried out.

An isomerised linseed oil can be obtained conveniently by heating linseed oil at 250°C for half an hour in the presence of 5 per cent of anthraquinone as catalyst under an inert atmosphere. The presence of conjugation is established by increase in refractive index, lowering of iodine value and substantial diene value. This is also confirmed by spectrophotometeric examination. The isomerized oil obtained has a beautiful greenish yellow appearance, the catalyst is recoverable completely, and the varnish made from the isomerized oil shows better drying properties and gives films with increased resistance to water, acid and alkali than raw linseed oil.

10. *Research Workers*—Sri J. N. Gupta and Sri B. M. L. Garg, Harcourt Butler Technological Institute, Kanpur.

Research Project—Study of the efficiency of different types of stills for the distillation of essential oils.

The object of the project is to compare the yield and quality of the oils obtained by the distillation of perfume bearing raw materials in several types of stills having different ratio of diameter to height and also differing in shape including the country stills.

The experiments were conducted in steam heated stills of capacity 18—50 and 55 gallons using lemon grass and lemon leaves with varying rates of distillation. It was found that to obtain maximum yield of oil in the least possible time, the rates of distillation are different for different raw materials.

It was observed that for lemon leaves, the rate of distillation should be between 1·35—1·4 litres per hour per cu. ft. of the still capacity where as for lemon grass, it is 0·85—0·90 litres per hour per cu. ft. of the still capacity. The results are given in the following tables :

Distillation of Lemon Grass (capacity of still 55 Gallons)

Rate of distillation per hour in litres	Per cent oil in 1st hour	Per cent. oil in 2nd hour	Per cent. oil in 3rd hour	Per cent yield on the weight of fresh leaves	Rate of distillation in litres/ hour per cu. ft. of still capacity
6 ...	45—46	37—40	15—18	0·110—0·121	0·63
8 ...	58—60	33—35	4—6	0·115—0·125	0·86
10 ...	60—62	30—33	4—5	0·115—0·129	1·07
12 ...	65—68	32—35	...	0·093—0·096	1·3

Distillation of lemon leaves (capacity of still 50 gallons)

Rate of distillation per hour in litres	Per cent oil in 1st hour	Per cent oil in 2nd hour	Per cent oil in 3rd hour	Per cent yield on the weight of fresh leaves	Rate of distillation in litres/ hour per cu. ft. of still capacity
6 ...	35—39	44—47	17—20	0·16—0·17	0·76
8 ...	44—50	40—45	5—6	0·18—0·19	1·01
10 ...	58—68	37—42	Nil ...	0·18—0·20	1·26
12 ...	64—68	32—36	Nil ...	0·18—0·20	1·4
Distillation of lemon leaves (capacity of still 18 gallons)					
3 ...	52—58	39—43	4—9	0·18—0·13	1.03
4 ...	60—65	35—40	Nil ...	0·19—0·20	1·37

Experiments were also conducted for determining the optimum conditions of distillation of rose flowers (Rose Edward) by maintaining different rates of distillation and estimating the percentage yield of oil in them on the weight of fresh flowers. The observations are given below :

Period of distillation	Per cent distillate on the weight of flowers	Per cent yield of oil on the weight of flowers
60 minutes	40	0·0073—0·0078
60 minutes	50	0·0094—0·0101
60 minutes	60	0·0115—0·0118

Thus the maximum yield is obtained when 60 per cent of the distillate on the weight of flowers is collected in one hour excluding the time required for heating the still.

Experiments were also made using elliptical, round bottomed and conical stills with flat bottom. Lemon grass was used in all the above experiments and the time of distillation, heating surface and the quantity of fuel were kept the same in all the cases. It was observed that the yield of oil did not differ much, the maximum being in the case of conical one.

11. *Research Workers*—Dr. Gopal Tripathi and Sri Ram Chandra Upadhyaya, Banaras Hindu University, Banaras.

Research Project—Chlorination of tar, asphalt and pitch for lubricants and solvents.

Chlorination of asphalt has so far been tried and the products obtained are mostly solids. Analysis for separation and identification of the products formed is in progress.

It is expected to obtain solvent like liquid hydrocarbons and lacquers from the chlorination of asphalt and pitches, which contain highly complex and resin like hydrocarbons under the effect of suitable catalysts. If appreciable yield of such solvents and lacquers is made possible, they can be of great technical importance.

12. *Research Workers*—Sri M. S. Bhatnagar and Sri G. S. Mathur, Harcourt Butler Technological Institute, Uttar Pradesh, Kanpur.

Research Project—Chromatographic estimation and separation of the constituents present in palma rosa, eucalyptus and lemon grass oil.

Separation of geraniol from the palma rosa oil is one of the very important problem of the perfume and essential oil industry. Palma rosa oil which is the main source of geraniol contains mainly about 65—95 per cent of geraniol, and in the next major portion of the oil are esters with citral, methylheptenone, dipentene and sesquiterpenes in traces

Geraniol from palma rosa oil has special value in perfumery in comparison with the geraniol from other sources like Java citronella oil or ginger grass oil. The difference in quality of the geraniol from different sources is very clear from the wide range of prices of the product, varying from Rs.13 to Rs.70 a pound.

There are various chemical methods of isolating geraniol from palma rosa oil, like phthalic anhydride and calcium chloride methods. The later one is usually employed commercially. But studies on the isolation of geraniol from palma rosa oil by calcium caloride method clearly show that there are number of variables which control the efficiency of the process. The purity and yield of the geraniol obtained by this method is also not very encouraging and the process is laborious.

We have tried a method for separating geraniol, based on the chromatographic absorption of the different constituents of the palma rosa oil on the alumina column, and have obtained geraniol of 97 per-cent purity and with the recovery above 95 per cent. The actual details of the experiment are as follows:

The palma rosa oil used for the chromatographic separation was analysed with the following results :

Sp. gravity 20°C	0·8066
Ref. index 20°C	1·4775
Acid value	1·27
Ester value...	32·63
Ester value after acetylation	257·62
Total free alcohol as geraniol	76·49

On the basis of the ester value the oil contains about 10 per cent esters. With a view to obtain pure geraniol in as much quantity as possible, the esters present were hydrolysed by alcoholic potassium hydroxide solution. The hydrolysed oil was dark brown in colour but was free of esters and higher in free alcohol percentage. The hydrolysed oil on analysis gave the following results:

Acid value	Nil
Ester value	Nil.
Ester value after acetylation	266·1
Per cent. of geraniol	87·58

Fifty c. c. of this palma rosa oil was made up to 100 c.c. in solvent oil (B. P. 55—65) and the solution was passed through an alumina column (145 gms.) dimensions 15 cms. × 3·5 cms. The column was developed with another 250 c. c. of solvent oil (B. P. 55-65, 50 c. c. at a time) and the first 100 c. c. of the filtrate was collected separately (until the oil band reaches the bottom of the column). The second fraction was collected separately with several times washings of the column, until practically all the oil comes with the solvent. The the two fractions were free from solvent. The first fraction was very little in amount for any analysis and the second fraction of the oil was about 44 c. c. and on analysis it was found to be 97 per cent. pure geraniol.

This fraction had the following physical and chemical characteristics:—

Ref. index at 20°C	1·477
Optical rotation	—1°
Acid value	Nil.
Ester value	Nil.
Ester value after acetylation	279·4
Per cent free geraniol	96·96

The process of isolating geraniol by chromatographic absorption is still under study, as there is a wide limit of alcohol per cent. in different types off palma rosa oils. For the present the study is based on finding out how much palma rosa oil could be passed through an alumina column of specified dimensions.

13. *Research Workers*—Prof. N. R. Dhar and Sri A. C. Gaur, Department of Chemistry, University of Allahabad.

Research Project—Researches on phosphates, their importance in nitrogen fixation and an inoacid synthesis.

There are regions in India where soils are deficient in phosphates; as such applications of phosphates under Indian conditions is now assuming importance. Phosphates are available in many forms, e. g. indigeneous products, bones, rock phosphates (Trichinopoly), bye-products of iron works just like basic slag and foreign product.

Very little work has been done on maintaining soil fertility by adding farm yard manure or composts. Composting is a method of altering the composition of organic matter resulting in a stable humus-like end product.

In cold countries, ammonium salts, urea, ammonium phosphate, super-phosphate and potash etc. have been added to facilitate the decomposition of cellulose and lignin present in the plant materials.

An elegant method of composting of plant materials has been worked out by us by adding small amount of phosphate and soil to the organic matter which has to be composted.

The material to be composted was first weighed and put into boxes. The requisite amount of soil was added and was mixed well with or without phosphates. Rock phosphate (Trichinopoly), basic slag and superphosphate are used at the rate 32·4 lbs. of P_2O_5 per ton of organic matter. The compost heap was kept moist throughout the period. After composting has continued for definite period the whole material was weighed and known weights of samples taken out for analysis. The influence of calcium phosphate has been studied in composting of organic matter like straw, dung and green weeds.

In case of straw composts the percentage of increase of nitrogen in control sets (without phosphate) is only 0·95 per cent. whereas in case of rock phosphate and super-phosphate treated sets, the percentage of increase of nitrogen is 8·9 per cent and 14·5 per cent respectively, after sixty days.

In case of dung composts, the percentage of increase of nitrogen in control set is 2·582 per cent whereas in rock phosphate, mixture of rock and super-phosphate and basic slag is 5·715 per cent, 13·940 per cent and 3·327 per cent respectively, after 45 days.

In composting of green weeds and other organic matter very poor in lignin, loss of nitrogen is much greater. It appears, therefore, that materials containing more lignin produce a compost which suffers less loss of nitrogen than materials poor in the lignin.

Experiments will be conducted with other materials like sawdust, water hyacinth, sawdust and straw, and sawdust and dung. Different types of phosphates like Indian basic slag (Tata and Kulti) and French rock phosphates will be used. In the composting experiments nitrogeneous materials like ammonium sulphate, sodium nitrate, urea, etc. will be used with different phosphates. Organic substances undergo oxidation forming carbonic acid. Moreover, there is formation of nitrous acid (dissociation constant 6×10^{-4}) and nitric acid when nitrogenous compounds undergo ammoniation and nitrification. When carbonic acid is passed into water containing tricalcium phosphate, the formation of dicalcium phosphate has been reported. Hence phosphate rock, especially soft rock phosphate not containing calcium fluoride and other sparingly soluble calcium phosphates are made available to crops with farm yard manure, straw, green manures, etc.

Hence organic matter mixed with phosphates is of great value, because it fixes atmospheric nitrogen and enriches the composts in available phosphates, potash, lime and trace elements.

14. *Research Workers*—Dr. J. G. Srikhande and Sri Purna Chandra, Government Agriculture College, Kanpur.

Research Project—Effect of trace elements on the biological decomposition of cellulosic materials.

The workers have shown that the loss of the dry matter gradually increases with the increased concentration of molybdenum as trace element, except with 10 ppm. concentration. The maximum loss occurred with 5 ppm. concentration at all the period studied. 38·13 per cent. at 60 days was the maximum loss obtained.

Total nitrogen also increased with the increasing concentration of molybdenum up to 5 ppm. beyond which there was a drop. The maximum nitrogen was obtained at the end of 45 days being 1·45 per cent. Denitrification appears to have commenced after 45 days.

Ammoniacal nitrogen, however, increased to a maximum of 9·453 per cent. with 5 ppm. concentration of molybdenum after 30 days and after that ammonia gradually decreased.

In the beginning there was no nitrate nitrogen but after 30 days it accumulated to a maximum of 0·147 per cent. with 5 ppm. concentration.

It has been further shown that high concentration of 10 ppm. of all trace elements (boron, cobalt and molybdenum) did not prove useful for composting and smaller concentrati n up to 5 ppm were helpful with sodium nitrate and ammonium sulphate.

The C/N ratio also went down to 12·63 after 45 days with molybdenum and sodium nitrate a source of nitrogen. The C/N ratio remained 15·8 with ammonium sulphate a source of nitrogen at 5 ppm. concentration of molybdenum.

C/N ratio in case of boron at 1 ppm with sodium nitrate after 45 days was 12·02 and with 5 ppm. with ammonium sulphate was 12·9.

Following fungi are to be tested at 30°C with ammonium sulphate and sodium nitrate as sources of nitrogen at intervals of 15, 30, 45 and 60 days.

1. Aspergillus niger.
2. Trichoderma alba.
3. Penicilium notatum.

Cytophaga hutchinsoni is also to be used.

In brief, following are the results of the decomposition studies at 15 days with ammonium sulphate as source of nitrogen and boron, molybdenum and cobalt at 0·1, 0·5, 1·0, 5·0 and 10 ppm. concentrations.

It is interesting to note that greater conservation of nitrogen took place in 15 days in presence of pure cultures than with mixed flora. It seems that boron, cobalt and molybdenum activated the growth of the fungus, increasing the nitrogen conservation. The maximum nitrogen conservation was observed with 5 ppm. of molybdenum being 5·10 per cent. over control followed by cobalt with 1 ppm. concentration being 4·8 per cent and boron with 5 ppm, being 3·6, respectively.

15. *Research Workers*—Dr. Sarju Prasad and Sri Jai Beni Prasad Tripathi, Banaras Hindu University, Banaras.

Research Project—Extraction of titanium compounds from ilmenite.

A number of mixtures, corresponding to sodium orthotitanate, $2Na_2O.TiO_2$, sodium metatitanate $Na_2O \cdot TiO_2$ and sodium metadititanate $Na_2O.2TiO_2$ were prepared by weighing out accurately ilmenite and sodium sulphate. In some experiments powdered charcoal, about 10 per cent. by weighing the mixture, was also added. All the constituents were mixed together and powdered well in an agate pestle and mortar. They were heated at 1150° to 1250° for about 4 to 10 hours. The heated mass was taken out, powdered well and analysed. The ilmenite used was from Travancore and on analysis gave the composition as follows :

Analysis of Ilmenite

—	Expt. no. 1	Expt. no. 2	Average
Silica	1·46% ...	1·50% ...	1·48%
Titanium dioxide ...	60·46% ...	60·52% ...	60·49%
Iron...	24·85% ...	24·97% ..	24·91%

The analysis of various titanates thus formed, shows that when the constituents of the mixture are in the ratio such as to form sodium-orthotitanates and heated at 1200—1250° for about 5 to 6 hours, nearly 75 per cent. of the TiO_2 along with 15 per cent of available iron are extracted from the heated mass by dilute H_2SO_4 (2N) The water extract does not give any test for Ti and Fe.

A number of mixtures were prepared by weighing out accurately ilmenite and sodium sulphate in various proportions. They were heated at high temperatures for different intervals of time. Experiments were carried out keeping in view the following three factors :

(i) The proportion of the constituents,

(ii) the temperature, and

(iii) the time.

Out of the above three factors two were kept constant and the remaining one varied. The heated mass was taken out, powdered well and treated with water. The quantity of alkali was estimated in the water extract. The residue was further treated with dil. H_2SO_4, iron and titanium were estimated as Fe_2O_3 and TiO_2 in the extract, It has been observed that when a particular proportion of the constituents was heated at a suitable temperature for a definite interval of time 85 per cent. of TiO_2 and 6 per cent. of Fe were obtained in the acid extract.

Further work to increase the percentage yield of titanium while to reduce that of iron is in progress.

16. *Research Workers*—Dr. M. L. Misra and Sri M. N. Gupta, Department of Glass Technology, Banaras Hindu University, Banaras.

Research Project—The utilisation of bentonite and Fuller's Earth in the ceramic industry.

The workers have submitted a detailed report which for lack of space, cannot be produced here in full. Fuller's Earth is a variety of alkaline clay having a high capacity for absorbing basic colours and can remove these colours from solutions in animal, vegetable and mineral oils as well as from some other liquids especially water. At present in Europe, America and other countries its chief use is in oil refineries for cleaning oil on a large scale. Fuller's Earth contains a good percentage of alkalies. It has a good plasticity and has a low fusion point, and therefore, it is a proper raw material to be used in ceramic industry as a substitute even though partially for feldspar in developing low temperature vitrified bodies. Because of its high iron content it may also be inferred that it would impart a reddish tinge more probably a brownish colour to the body. But instead of getting rid of this colour, it may be used for making Rockingham wares with low temperature dark, brown bodies with a suitable brown coloured or transparent glaze. A ware similar in colour to Rockingham ware is made in India at Chunar. This ware is made of ordinary earth and very high lead containing glazes are used, and is fired at a very low temperature of about 850°C. This low temperature fired body with a high lead glaze is not suitable for being used as a dinner ware due to the solubility of lead in hot liquids or foods. This is mainly a terracotta ware in all aspects and is different from Rockingham ware This type of Chunar ware is very likely to produce lead poisoning as according to Thorpe's formulae the solubility of lead in such things should not go beyond 5·0 per cent. Rockingham ware is usually used for storing foodstuffs and other things while Chunar ware does not find place in the category of this class of articles. Due to this very reason it was considered proper to use Fuller's Earth and Bentonite in the manufacture of low temperature fusing bodies, like Rockingham ; and use them for food containers.

Occurrence in India—Jodhpur Division Rajasthan *Kapurdi* 25° 54½′ : 71° 22′.

A good deposit of Fuller's Earth at Kapurdi in this State has been mentioned by Heron. But Bhola has given a detailed description of the same. The area in the neighbourhood of Kapurdi is occupied by Malani Rhyolites which are overlain by Barmer sandstones. The Fuller's Earth beds directly over-lie the Barmer sandstone and is supposed to be of Cretaceous Age.

The deposits occur in the form of a basin approximately 4,400 feet by 750 feet and the Fuller's Earth bed is found resting about 12 feet above a coarse, ferruginous sandstone which crops out of sand on the east flank. Immediately overlying the earth is a 3″ to 6″ band of hard iron-stone which in turn is overlain by thinly-bedded shale, generally spintery, then by clay containing selenite crystals and is finally capped by varying thickness of Kankar, laterweed material

and sand. At places, the lateritic portion contains fragments of Rhyolites. At times an iron stone band varying from a few inches to 2 feet is also found in the middle of Fuller's earth and occasionally limonite nodules are found within the earth. In the underground working the beds show an average dip of about 15°—20° though at times high dips of 28° have also been recorded. The thickness of this bed varies from 4—10 feet; and it has been observed that as the centre of the basin is approached the thickness increases. The deposit is situated at a distance of 10 miles from Utarlai railway station. This deposit is not associated with lignite or limestone as in the case with the Fuller's Earth deposits of Palana of Bikaner Division.

Rohli—(25° 58′ : 71° 23′) Another deposit of Fuller's Earth occurs at a distance of one mile east of Rohli Village. The material appears to be of good quality and it can be excavated in large lumps. The deposit lies at a distance of 12 miles from Utarlai, the nearest railway station.

Jaranada—This deposit lies at more than 6 miles from Shes (26° 11′ : 71° 15′). The material is equal in quantity with that found at Kapurdi and can be obtained in big lumps. These deposits are situated at a distance of 32 miles from Barmer Railway Station and at a distance of 6 miles from Barmer Jaisalmer motor road.

Dip-ki-Dhani—Fuller's earth occurs at a distance of about 3 miles east of Barmer (25° 44′ 30″ : 70° 23′). These deposits are overlaiden by conglomeratic boulders of Rhyolite probably of sub-recent age. The deposit extends to about 550 feet in length and lie at a distance of only 3 miles from the Barmer railway station.

Out of these four deposits, that at Kapurdi is the only one which is being exploited economically. The mining is done crudely by digging two tunnels inside the deposits and recovering the material therefrom. Recently the pillar and stall method of mining has been introduced. The depth so far reached is more than 38 feet. It is estimated that the deposits are very huge and contain about 1,04,000 tons of the material At the present rate of mining the deposits is expected to last for 50 years. The material as it comes out from the mine is sorted out into two grades.

Grade no. 1. Soft and whiter material.

Grade no. 2. The remaining after sorting out grade one. The lumps in this are about 2″×2″ in size, 30% of the material goes as a waste.

This material has been tested for bleaching of oil and has been reported as "most satisfactory and useful". It compares well with the American product.

Kashmir State—A type of clay which according to the *Middle-Miss* may be Fuller's Earth is reported to occur in Budil area of Rampur-Rajwri Tehsil. The exact localities where the outcrops of this material are met with are (1) near Budil (33° 22′ 30″ : 74° 39′), (2) at a distance of 2 miles North West of this place and (3) at Kandra hill 2½ miles North-West of Budil.

It seems that the mode of occurrence of this earth is not clear but at one place it is seen to overlie a trap rock of intrusive nature and occurs in slate beds.

The colour of this clay is bluish-white. It is soft and soapy to touch. When dug it is reported to come out in hard lumps; but on exposure it falls into powder. It slakes also in water. It is easily fusible and fuses into a dark blue enamel like mass in a few minutes. It is reported that it may not be a very useful material in oil refining. It clears the greasy or oily spots from the cloth.

Bhimber—A bed of Fuller's Earth occurs (32° 58′ : 74° 5′) interstratified with the upper Siwalik Conglomerates of Bhimber in Jammu Province. The thickness of the bed is a few inches only. The material is soapy, waxy and soctile and of high absorbent nature. The bed occupies a wide area and can be traced for a few miles.

Madras Presidency—Anantpur Fuller's Earth occurs at Anantpur in the Madras Presidency. Details are not available.

Jaisalmer State—Mandar Fuller's Earth is reported to occur at Mandar about 5 miles north of Khewalsir (27° 15′ : 70° 54′). No other details or information is available.

Bikaner Division (Rajasthan)—*Mar*—(27° 57′ : 73° 0′) Deposits of Fuller's Earth are reported to occur at a village Mar. At this locality is seen a ridge almost entirely composed of sandstone of age older than Nummulitics. This ridge runs from Kolayt about 20 miles due west of Palana. At the southern end of the ridge, at the village Mar, a deposit of Fuller's Earth is reported to occur. The material from this deposit is locally known as Multani Mitti and is quarried and sold in the market. It is yellowish in colour and is plastic. It swells very much when soaked in water. It is supposed to be a good quality Fuller's Earth suitable for the purpose of bleaching oils.

Palana—(27° 57′ : 73° 19′) At Palana a bed of Fuller's Earth has been encountered at a depth of 53 feet while boring operations for coal were in progress. The thickness of this bed is 38 feet In the bore hole at a depth of 114 feet another 20 feet thick bed was encountered and yet another bed of 2 feet in thickness was encountered at a depth of 286 feet. The highest bed is sandy and due to its containing nummulitics, it has become somewhat calcarious in nature The quality of the material is supposed to be inferior to that of Mar. These beds are supposed to be very good reservoirs of Fuller's Earth of this State.

Fuller's Earth also occurs at Koloyat in Bikaner State and near Jhimpur in Khairpur State and Rohri in Sind.

Bihar—Fuller's Earth is said to occur in association with the clays of Pathargatta Hill (25° 20′ : 87° 14′) in the Bhagalpur District. This product from here is being sold as "Sabun Mitti". It is soft and soapy to touch. Dr. Fore has reported the occurrence of Fuller's Earth at Dudam-alia-Pat (23° 29′ : 84° 36′) in the Ranchi District. It is supposed to be kaolin having the properties of Fuller's Earth.

Bombay—In Kothapur District, Fuller's Earth is said to occur but no details are available. Also a ship layer of black-reddish earthy substance yielding a soft powder having absorbent power, occurs associated with gypsum in the marine clays of Kuranga in the Baroda State.

Central India—Fuller's Earth is said to occur at Chandevi and Sabalgaro parganas in the Gwalior State.

Central Provinces—Kanti (23° 50′ : 30°24′) Fuller's earth is said to occur at Kanti in the lower Vindhyan series.

Hyderabad—In this State Fuller's Earth occurs in fairly large quantities. The beds occur near Kundhati, Chemi, Idlai, Peddomal, Gingurti and Kiroli in Chincholi. It is used in oil refining.

Mysore State—A fairly good amount of Fuller's Earth is quarried at Jumkur (13° 20′ : 77° 5′) but the quality of the materials is doubtful for useful purposes.

The authors have determined physical properties and have carried on experiments on P. C. E., dehydration, thermal behaviour and chemical behaviour. The authors work on bentonite which is a clay like substance formed by the weathering or alteration of volcanic rock and which is composed of minerals of the montomorillonite family, deserves attention. Bentonite occurs in Kashmir, Punjab and Rajasthan. The authors have given sheir results or Pyrometric Cone Equivalent tests, dehydration study, differential thermal study, and chemical analysis. A variable quantity of bentonite was used replacing the clay content in the ceramic body composition and the comparetive results have been given. Bentonite for its over fusibility and great binding power and Fuller's Earth for its very low fusibility and high bindiug power were considered to be good bonds for making abrasive wheels out of corrundum. A small amount of these two new materials were, therefore, used for this purpose. Corrundum was crushed to grains and then it was sieved to different sizes. It was found that a body containing 10% of Fuller's Earth was the best and it was verified very satisfactorily. It was very strong and yielded good results when fired to 1250°C. It was also found that although bodies with bentonite as a bend were strong enough when in the green stage did not develop so good a verified body at 1250°C as that with Fuller's earth. This was due te the fact that bentonite has a higher fusion point, The low fusion and great binding power of Fuller's earth was responsible for developing a good bond at 1250°C.

Ina further report the workers have described in details such physical propertiss of Fuller's earth as colour, form, specific gravity, plasticity, Attabvrg number, water of plasticity, air shrinkage and pure water. They have further described the fired properties, for example, shrinkage, porosity, and absorption at different temperatures. The other useful properties noted by the authors are differential thermal anylysis, dehydration, expansiun, chemical analysis, and microscopic study of the residue left after washing the clays. The report is exhaustive and will be very useful if published in full for the workers interested in the subject.

17. *Research Workers*—Dr. H. M. Roy and Sri T. N. Mukundan, Department of Ceramics, Banaras Hindu University, Banaras.

Research Project—Study on Indian natural abrasives.

Such substances as have their hardness about that of felspar in the Mohs scale of hardness are known as abrasives, for example, diamond corundum, garnet, emery, topaz, and quartz. Their role is cutting, drilling, grinding, polishing, or preparing a surface for receiving an even polish. Besides the high grade natural abrasives like diamond, corundum, garnet, emery, etc., there are siliceous abrasives also as flint, quartz quartzite, sands and sandstone, talc, pumice, felspar, etc. The workers have described the place of diamond, corundum, emery, garnet, flint, quartz and quartzite, sands and sandstones, deatomaceous earth, tripoli, talc, pumice, volcanic dust, rottenstone, and felspar, among the well known list of abrasives. They have also described the distribution of these abrasives in various parts of this nountry and also their common uses. Abrasives reach the miarket in three general forms : (i) as bonded sheets, wheel segments discs, etc. as sticks and similar shapes, (ii) as a coating on paper or cloth in small sheets or continuous strips, and (iii) as loose grains either dry or in paste form. The author has worked out in details such physical and chemical properties of corundum as well as the microscopic examination of those abrasives as may be necessary from the point of view of the study of abrasives. As corundum powder was non-plastic, the tensile strength, crushing strength, shrinkage, etc., was determined in an indirect way. For this purpose a small amount of plastic clay which would soften at the baking temperature of the test pieces was advantageously added to the powder. The processed corundum grit was further used for making abrasive wheels. The authors have described vitrified bonds which are compounded from felspar, clay, quartz, etc., all finely ground and mixed with abrasive grit and pressed into wheels. A low melting grit was compounded for the purposes of being used as a bond from borax, quartz, felspar, kaolite, whiting, in small places of oxides of sodium, potassium, calcium, aluminium, silicon and borax. Wheels were also made from artificial abraeive like silicon carbide with a suitable amount of some bond. The workers have also described silicon bonds containing clay, zinc oxide and other fillers. Silicate bonded wheels require more bond than in the vitrified one so as to get the same grade. These wheels are not so open as that of the vitrified ones. They can, however, be made rather cheaply and in larger sizes than vitrified wheels owing to the manufacturing risk of the latter. The authors have further described their observations of resin bonds, shellac bonds and rubber bonds.

18. *Research Worker*—Dr. K. D. Jain, Chemical Laboratories, D. A.-V. College, Dehra Dun.

Research Project—Studies on the reaction between gelatin and potassium dichromate with a view to find out conditions for the production of an adhesive insoluble in polar and non-polar solvents.

The reaction between gelatin and potassium dichromate has been studied to find conditions for the productions of an adhesive insoluble polar and non-polar solvents. It is found from the experiments

conducted so far that reaction takes place at room temperatures during summer and winter. The rate of reaction in summer is rapid while in winter very slow. The rate is increased by exposure to light and at higher temperatures and it is not possible to determine the rate of reaction. The amount of dichromate actully reacting with a fixed quantity of gelatine depends upon its own quantity and also upon the duration of the exposure to light. Potassium dichromate is reduced while gelatin tends to be insolubilized.

A fabric piece dressed with the above reaction mixture was highly exposed to light and dried which was then dipped in non-polar solvents like alcohol, petrol, benzene, ether, etc, and the dressing was not effected. In polar solvents like water, proofing material in the fabric appeared slightly swelled. The fabric is also stiff. This requires addition of some plasticisers.

The project on completion will produce a cheaper resin capable of resisting the action of water, alcohol, petrol, benzene, etc., and will be useful in waterproof industries like waterproof type sand and every paper cloth, fuel pump diaphragm, waterproof cloth, shoes, tarpaulin, covers, etc.

CHEMISTRY

1. *Research Workers*—Dr. Satya Prakash, D. SC., and Dr. S. C. Tripathi, Chemical Laboratories, University of Allahabad, Allahabad.

Research Project—Studies on chelate complexes with special reference to acetyl acetonates.

Papers published—

(1) A note on the hydrogen on concentration and absorption of nickel acetyl acetonates. J. Ind. Chem. Soc., 1956, 33, 767.

(2) A review on chelate rings. J. Chem Soc., University of Allahabad, Vol. XXIII, 1955-56.

(3) Composition of uranyl o-cresotate complex, Z. phys. Chem. (in press).

(4) Composition of ferric o-cresotate-a spectrophotometric study Z. Phys. Chem. (in press).

(5) Composition of cupric o-cresotate chelates: A colorimetric Study. J. I. C. S. (in press).

(6) Complex formation of uranyl with o-cresotic acid, A potentiometric colorimetric and conductometric study, J. I. C. S. (in press).

(7) Composition of uranyl 1, hydroxy 2, naphthoate chelate : colorimetric study, J. I. C. S. (Accepted for publication).

(8) Complex formation of uranyl with 1, hydroxy 2, naphthoic acid : A potentiometric and conductometric study, Vijnana Parisad Anusandhan Patrika, 1958.

Under this project investigations of various metallic complexes with organic ligands as acetyl acetone, o-cresotic acid and 1, hydroxy 2, naphthoic acids have been made with the help of different physicochemical methods.

It has been shown by the authors with the help of potentiometric and absorption studies that univalent nickel forms a very stable complex with acetylacetone at about pH 8.0 which is not dissociated even up to pH 12.0.

O-cresotic acid serves as a good chelating agent. Various metallic complexes of o-cresotic acid have been studied by us. Potentiometric, conductometric and colorimetric studies show that uranium forms a red coloured complex with a o-cresotic acid at about pH 4.5 containing uranium and o-cresotate in 1:1 mole ratio. Beryllium and copper form two complexes with o-cresotic acid containing metal and o-cresotate in 1:1 and 1:2 mole ratios respectively. Whereas aluminium, uranium and ferric iron form only one complex in acidic medium containing the acid and the metal in 1:1 ratio.

Like o-cresotic acid few metallic complexes with 1, hydroxy 2, naphthoic acid have also been investigated employing the physicochemical methods as potentiometric, conductometric, colorimetric and spectrophotometric.

Similar to o-cresotic acid beryllium forms two complexes with 1, hydroxy, 2, naphthoic acid; one in acidic and the other in alkaline medium containing beryllium and 1, hydroxy, 2 naphthoic in 1:1 and 1:2 mole ratios, respectively, whereas uranium forms only one complex containing the two in 1:1 mole ratio.

The composition of above mentioned complexes of o-cresotic and 1, hydroxy, 2 naphthoic acids have been determined by Job's method of continuous variation either spectro-photometrically or colorimetrically. In the formation of the metallic complexes of the two acids hydroxyl and carbolyx groups take part and hydrogen of the two groups are displaced by the metals.

The research assistant received his D.Phil. degree from the University of Allahabad on this work.

2. *Research Workers*—Prof. S. Ghosh and Dr. M. P. Singh, University of Allahabad, Allahabad.

Research Project—Kinetics of reduction of Fehling's and Benedict's solution by reducing sugars:

(i) The oxidation of glucose, galactose, fructose, l-arabinose and d-xylose by alkaline bivalent copper in presence of sodium potassium tartrate and sodium citrate has been studied. It has been observed that reaction is unimolecular with respect to reducing sugar and zeromolecular with respect to copper complex. The effect of alkali and tartrate or citrate has also been investigated.

(ii) The general conclusion that emerges out of this investigation is that cupric ion forms a complex with tartrate or citrate and it is in the form of complex salt that copper reacts with sugar molecule. The minimum amount of Rochelle salt that has been required is equivalent to copper sulphate. In case of citrate the amount required is slightly greater than the equivalent amount to keep copper in solution.

(iii) A major factor on which the velocity of this reaction depends is the concentration of alkali taken. The reaction velocity increases with the increase in the hydroxyl ion concentration. In general in the lower concentration ranges of alkali, the velocity increases with the increase in the amount of free alkali taken. At higher concentration ranges of alkali the increase is not to the same extent as in the lower ranges.

(iv) A preliminary investigation of the kinetics of reduction of Fehling's solution immediately revealed the fact that a hexose or a pentose sugar undergoes intramolecular rearrangement before it is oxidised to carbon dioxide, water and the acid. A comparison of the rate process of $\alpha \rightarrow \beta$ transformation or a hexose or pentose sugar with the rate of oxidation of the sugar molecule by bivalent copper further revealed the fact the velocity of $\alpha \rightarrow \beta$ transformation (mutarotation) is about a million times greater than the intramolecular transformation which takes place when a hexose or pentose molecule is oxidised by bivalent copper. Yet at the very outset the authors became certain that the rate determining step in the oxidation of sugar (say gulcose) is som intr a-molecular rearrangement which is strongly catalysed eby the

presence of alkali and ultimately they have arrived at the interesting conclusion that the intramolecular rearrangement is no more than the enolization (i.e., the enediol formation) of the aldehydo as well as the keto sugar which is the rate determining step in the oxidation of a hexose or a pentose sugar by the bivalent copper. Once this intermediate enediol is formed, the latter reacts immediately with the bivalent copper which is present in the form of a complex tartrate or citrate.

$$\underset{\text{d—glucose}}{R\text{—}CH(OH).CHO} \xrightarrow[OH]{\text{slow}} \underset{\text{enediol}}{R.C(OH)=CH\,OH} \text{——(1)}$$

In general the following scheme for the oxidation of a hexose, for example, may be given as most general scheme :

$$\underset{\text{enediol}}{R\text{—}C.OH=CH.OH} + Cu\text{—complex} \xrightarrow{\text{fast}} Cu_2O + \text{other reaction products} \text{——(2)}$$

Similarly with d—fructose :

$$\underset{\text{d—fructose}}{R_1CO\text{—}CH_2OH} \xrightarrow[OH]{\text{slow}} \underset{\text{enediol}}{R_1C(OH)=CH(OH)} \text{————(1)}$$

$$\underset{\text{enediol}}{R.C(OH)=CH(OH)} + Cu\text{—complex} \xrightarrow{\text{fast}} Cu_2O + \text{other reaction products} \text{——(2)}$$

This work has provided a better picture of the mechanism for the reduction of cupric salt complex by a sugar, a reaction of great importance and general utility.

The research assistant, Sri M. P. Singh got his D. Phil. degree on the work done by him on this project.

3. *Research Workers*—Dr. Abani K. Bhattacharya and Sri Amal Kumar Bhattacharya, Chemistry Department, Agra College, Agra.

Research Project—Slow coagulation of colloids.

Papers published—(1) Verification of a new equation in the study of the slow coagulation of lyophobic sols by different techniques—J. Coll. Sci., II, 124 (1956).

(2) A new equation between the time of coagulation and electrolyte concentration studies on copper ferrocyanide sol.—J. Coll. Sci, 10, 551 (1955).

(3) The importance of the point of inflection in the viscosity-time curve of the slow coagulation of colloids.—Curr. Sci. 24, 333, (1955).

(4) A tyndallometric study connecting electrolyte concentration and time of coagulation.—J. of Coll. Sci., 11, 171 (1956).

(5) Viscosity changes during the slow coagulation of ferric hydroxide sol, and the verification of the new equation, connecting the electrolyte concentration and time of coagulation. Kolloid—Z., 148, 136 (1956).

(6) The relation between the time of coagulation and electrolyte concentration; studies on the prussian blue sol. Kolloid-Z., 148, 140 (1956).

(7) Contribution to kinetics of slow coagulation of lyophobic sols by viscometric method. Part I—Arsenious sulphide sol. Kolloid-Z., 141, 95 (1955).

Kinetics of slow coagulation of As_2S_3 sol. was studied by means of the Freundlich's equation by measuring the changes in viscosity during coagulation in presence of lithium, sodium and potassium chlorides. The change in viscosity with time was autocatalytic and the values of the velocity constant determined by the Freundlich's equation were satisfactory.

The importance of the point of inflection in the S-shaped curve was recognised for the first time to denote the kinetic stage in slow coagulation, where $\frac{d^2x}{dt^2}=0$. Hence, it was assumed that the points of inflection in the viscosity-time curves should express the same state of aggregation, or in other words the same stage of coagulation for the different concentrations of the same electrolyte. This enabled the workers to verify the new equation developed by them showing the relation between concentration of the electrolyte and time of coagulation.

There are various techniques to study coagulation of sol and it is a known fact that the values given by different techniques are different. Hence, in order to establish the validity of the new equation, it was necessary to see whether it can stand the test of the coagulation values of a particular sol, obtained by different authors by employing different techniques. The data of several eminent authors were collected from literature and the relation between the concentration of the electrolyte and the time of coagulation was checked as suggested by these workers. It was observed that the data obtained by eminent workers by the teichniques: (1) viscosity, (2) light absorption, (3) extinction coefficient and (4) counting of particles were in agreement with the new equation.

The relation between the concentration of electrolyte and time of coagulation was studied on copper ferrocyanide sol and the data were found to satisfy the equation.

Viscosity changes were studied during coagulation of ferric hydroxide sol and the equation was verified ; the data were published in Koll-Zeit. (1956).

The coagulation studies made by Tezak and co-workers tyndallometry (Jour. Phys. Coll. Chem. 55 (1951—1957) on silver halide sols. gave interesting data to correspond to definite stages of coagulation. The agreement of their data with the equation has been shown in one of the papers (1956).

The relation between the time of coagulation and electrolyte concentration was studied on the prussian blue sol. The data were studied in the light of the equation and were found to be satisfactory.

4. *Research Workers*—Dr. G. S. Deshmukh and Sri M. K. Joshi, Banaras Hindu University, Varanasi.

Research Project—Detection and determination of rare elements.

Papers published—(1) 'Die Bestimmung von Uran mit Alkalihexacyanoferrat'. *Z. anal. Chem.* 143, 334 (1954).

(2) 'Iodometrische Bestimmung von Uran . *Chemische Berichte*, 87, 1446 (1954).

(3) 'Die Oxydation von Uran IV durch Selenige Saure'. *Chemische Berichte*—88, 186 (1955).

(4) 'Determination of Thiocyanate by Ceric Sulphate', *J. Ind. Chem. Soc.* 31, 413 (1954).

(5) 'Die Endpunktsanzeige durch Iodmonochlorid beider Oxydation von Rhodanid durch Kaliumpermanganat', *Z. anal. Chem.*, 142, 275 (1954).

(6) 'Iodine monochloride end point in the oxidation of thiocyanate by permanganate. Determination of cerium'., *Z. anal. Chem*, 145 (1955).

I. *Analytical Aspects of the Chemistry of Uranium.*

1. *Colorimetric Micro-Determination of Uranium*—It was observed that uranium salts in presence of acetic acid give an intense red colour with an alcoholic solution of cresotic acid (a phenolic acid). The test was found to be very sensitive and capable of detecting microquantities of uranium. However, W, Mo, Ce IV, Th, Fe and phosphates interfere with the above test.

The above test has been adopted for the colorimetric micro-determination of uranium. These experiments were carried out with the help of Spekker Photo-electric colorimeter. Over a certain range of uranium concentration the system was found to obey Beer's law. Curves plotted for the molar concentrations of uranium against

extinction coefficient or percentage transmission are straight lines confirming the validity of the above statements; very dilute solutions of unknown uranium content were used and from the values of the extinction coefficient, a quantitative determination of uranium has been made by referring to the standard curves.

2. *Iodometric Determination of Uranium*—B. Glassman (Ber., 37, 189—191, 1904) observed that faintly acidic solutions of uranyl salts interact with iodate-iodide mixture according to the equation, $3UO_2(NO_3)_2 + 5KI + KIO_3 + 3H_2O \rightarrow 3UO_2(OH)_2 + 6KNO_3 + 3I_2$, and that the reaction proceeds quantitatively in the course of a few minutes when the solution was warmed. The liberated iodine was driven over with steam and then absorbed in a receiver containing KI solution and titrated against standard thiosulphate. Preliminary experiments in these laboratories showed that pH of the uranyl solution is an important determinant in this method, and the term 'neutral or faintly acid' adopted by Glassman was too vague to give a quantitative picture of the process. The problem was, therefore, reinvestigated carefully using uranyl sulphate in place of nitrate. A stock solution of uranyl sulphate was prepared by dissolving E.Merck's sodium uranate in sulphuric acid. Its uranium content was found out by the classical oxinate method. To an aliquot volume of UO_2SO_4 taken in a round bottomed distilling flask a dilute solution of NaOH to raise its pH to 4.1 to 4.3, was added. A measured excess of 0.1 N KIO_3 and 50 per cent KI solution were added followed by 5—10 ml. carbon tetrachloride. The contents of the flask were refluxed on a water bath using a water condenser for 15—20 minutes. On cooling, the iodine set free was titrated against standard sodium thiosulphate in one set and against standard arsenious oxide in buffered medium (borax-boric acid) in another similar set. In a few experiments, the precipitated uranium hydroxide was filtered, washed free of iodate and iodide, ignited and weighed as U_3O_8. The quantity of uranium calculated from all these methods was found to agree well with the standard oxinate value. It may be pointed out that these experiments lead to a new method of estimating uranium with As_2O_3 as a primary standard. Furthermore, the improved experimental technique of the process enhances the scope and applicability much more than that envisaged by Glassman.

3. *Volumetric Determination of Uranium by Alkaline Ferricyanide*—The volumetric determination of uranium is based mainly on its reduction to the quadrivalent state and re-oxidation with a standard oxidant. The reduction is generally accomplished by zinc. In this as also in other reduction processes a mixture of trivalent and quadrivalent uranium is usually obtained, the trivalent uranium being then air oxidised to the U^{IV} state. Quantitative reduction directly to the quadrivalent stage has been achieved with liquid zinc amalgam and silver under certain experimental conditions. Amalgamated zinc in the form of a Jones reductor is perhaps the most widely used reductant. Campbell and Griffin (Ind. Eng. Chem., Anal. Ed., I, 661—665, 1909) and Jander and Reeh (Z. anorg. Chem., 129, 293-301, (1923) used metallic aluminium in sulphuric acid solution for the quantitative reduction of U^{VI}/U^{IV}. The generally employed oxidising agents are $KMnO_4$, $K_2Cr_2O_7$, $Fe_2(SO_4)_3$ and $Ce(SO_4)_2$.

Since available information in the literature on the use of alkaline $K_3Fe(CN)_6$ as an oxidant for U^{iv} was meagre, this redox reaction was investigated in some detail. In the actual procedure, uranyl salt was prior reduced to uranous state by Al and H_2SO_4 and re-oxidised by a known excess of alkaline potassium ferricyanide solution. The uranium content of a given solution is calculated by estimating the amount of ferrocyanide formed and the quantity of ferricyanide reacted in terms of $Ce(SO_4)_2$ $Na_2S_2O_3$, and/or As_2O_3 respectively.

Whereas the oxidation of U^{iv} to U^{vi} by $K_3Fe(CN)_6$ was quanitative over a wide range of alkali concentration, too large an excess of the oxidant (more than twice the theoretical) gave deviating results. A remarkable feature of this method is that in the titration of ferrocyanide by ceric sulphate no indicator is needed. Uranium ferrocyanide formed during the course of the reaction services itself as an internal indicator. The titration is carried out with vigorous shaking and a dropwise addition of ceric sulphate. A gradual dissolution of the uranyl ferrocyanide occurs and the end point is characterised by a sharp colour change from deep red of uranyl ferrocyanide to the deep yellow of uranyl ferricyanide. Similarly in the iodometric determination of excess ferricyanide against thiosulphate and/or arsenious oxide, a sharp colour change from blue to deep red or brown indicated the end of the titration.

In general, titrations of U^{iv} to U^{vi} are carried out at elevated temperatures and involve the risk of aerial oxidation. Since in this case an excess of the oxidant is being used in an inert atmosphere, this possibility is eliminated. Furthermore, the use of $Ce(SO_4)_2$ and As_2O_3 as primary standards in the titrimetric determination of uranium offers a distinct advantage.

4. *Determination of Uranium by Selenious Acid, a Concurrent Volumetric Gravimetric Method*—Review of literature showed that no attempt was ever made on the use of selenious acid as an oxidant for quadrivalent uranium. This work was, therefore, undertaken and a concurrent volumetric-gravimetric estimation of uranium has been developed.

An aliquot volume of uranyl sulphate solution was reduced by means of zinc and sulphuric acid and the solution filtered through Whatman no. 41 filter in a round bottomed distilling flask. The unreacted zinc was washed several times. A current of air was bubbled for 5-10 minutes through the U^{iv} solution to oxidise any U^{iii} formed. A known excess of selenious acid and an adequate quantity of hydrochloric acid to maintain its overall content in the system 2-3N were now introduced and the flask fitted with a Liebig' condenser. An inert atmosphere (nitrogen) was maintained and the system refluxed for about 30 minutes till the grey-black metallic selenium separated and settled down. The condenser was detached and the selenium filtered over a previously weighed Gooch crucible and washed several times with water. The filtrate and washings were collected for estimation of the excess selenious acid. The metallic selenium in the crucible was treated with absolute alcohol and ether and finally heated to 110-120°C to constant weight.

The excess H_2SeO_3 in the filtrate was made to 500 ml. and 100 ml. portions of this were taken for the iodometric titration against standard sodium thiosulphate from the following equations :

$$2UOSO_4 + H_2SeO_3 \rightarrow 2UO_2SO_4 + Se + H_2O \quad \text{(i)}$$

$$H_2SeO_3 + 4HI \rightarrow Se + 2I_2 + 3H_2O \quad \text{(ii)}$$

$$4Na_2S_2O_3 + 2I_2 \rightarrow 2Na_2S_4O_6 + 4NaI \quad \text{(iii)}$$

Hence $2U \equiv 1H_2SeO_3 \equiv 1Se \equiv 4Na_2S_2O_3$, or, 1 ml. of 0.1N thiosulphate $=0.01191$ gm. uranium and 0.10 gm.Se by weight$=0.6027$ gm. U. Results of a series of experiments performed volumetrically and gravimetrically reveal a close correspondence with each other and these compare favourably with the classical oxinate values.

The remarkable stability of selenious acid on boiling in acid solutions, its simple iodometric determination and the ease with which the metallic selenium is obtained in weighable form, make the present method of estimating uranium simple, accurate and broad-based. Its special feature is the concurrent gravimetric and volumetric analysis in a single operation.

5. *Alkaline Iodine as an Oxidant for Uranium IV*—Preliminary experiments in these laboratories showed that when an aqueous solution of iodine in KI was added to uranous sulphate solution followed by sodium hydroxide, rapid oxidation of U^{IV} to U^{VI} occurred. Since this finds little mention in the existing literature, it was interesting to study the redox process in some detail and utilise it for the quantitative determination of uranium

An aliquot portion of uranyl sulphate solution was reduced by pure zinc and sulphuric acid in cold. The contents of the flask were filtered through a Gooch crucible and the unreacted zinc washed several times with dilute H_2SO_4 and then with distilled water. A stream of air was bubbled through the cold uranous solution for 5 minutes to oxidise any U^{III} formed to U^{VI}. An inert atmosphere was maintained by passing a slow stream of nitrogen gas and a measured excess of standard iodine solution followed by 3N sodium hydroxide solution till a yellow precipitate was obtained. After 15—20 minutes the alkali was neutralised and the unreacted iodine titrated with standared thiosulphate as usual to the starch end point. In another set, the free iodine was titrated against standard As_2O_3 in presence of borax-boric acid buffer. The following reactions take place :

$$I_2 + 2OH \rightarrow I^- + IO^- + H_2O \quad \text{(i)}$$

$$UOSO_4 + IO \rightarrow UO_2SO_4 + I^- \quad \text{(ii)}$$

$$3IO^- \rightarrow 2I^- + IO_3^- \quad \text{(iii)}$$

$$5I^- + IO_3^- + 6H \rightarrow 3I_2 + 3H_2O \quad \text{(iv)}$$

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI \quad \text{(v)}$$

$$2I_2 + 2H_2O + As_2O_3 \rightarrow 4HI + As_2O_5 \quad \text{(vi)}$$

Thus $1U \equiv 2Na_2S_2O_3$ or $\frac{1}{2}As_2O_3$, or, in other words 1 ml. of 0.1N thiosulphate or arsenious oxide$=0.01191$ gm. of uranium. Results in close agreement with the classical oxinate procedure have been obtained. Besides its simplicity and accuracy, the chief advantage of the present method is the use of As_2O_3 as a primary standard.

6. *Studies in the Composition of Uranium Selenite*—Conflicting statements have been made in the literature on the formation and exact composition of uranium selenite. It was observed that an addition of an aqueous solution of selenious acid to a solution of uranium nitrate or sulphate in presence of 50 per cent alcohol and in a pH adjusted between 4 and 5, results in the quantitative precipitation of a yellow-white uranyl selenite. A composition study of this compound was, therefore, thought desirable. The precipitated selenite was filtered through Whatman no. 42 and washed free of excess selenious acid by rectified spirit. It was dissolved in conc. HCl and the liberated H_2SeO_3 was titrated iodometrically against standard thiosulphate. These results showed that 1 mol of U combined with 1 mol of H_2SeO_3 suggesting the composition of uranium selenite as $UO_2(SeO_3), xH_2O$.

In order to determine the associated water molecules, the compound was filtered through a sintered glass crucible, washed with absolute alcohol and acetone and finally desiccated to constant weight. From the weight of the precipitate, the composition of the selenite was confirmed as $UO_2(SeO_3)$. Since the precipitation of uranyl selenite is quantitative under the above-mentioned conditions it was contemplated to extend these observations for a volumetric estimation of uranium. The following reactions take place :

$$UO_2SO_4 + H_2SeO_3 \rightarrow UO_2SeO_3 + H_2SO_4 \quad \text{..... (i)}$$

$$UO_2SeO_3 + 2HCl \rightarrow UO_2Cl_2 + H_2SeO_3 \quad \text{..... (ii)}$$

$$H_2SeO_3 + 4HI \rightarrow Se + 2I_2 + 3H_2O \quad \text{..... (iii)}$$

$$4Na_2S_2O_3 + 2I_2 \rightarrow 2Na_2S_4O_6 + 4NaI \quad \text{..... (iv)}$$

Thus $1U \equiv 1H_2SeO_3 \equiv 2I_2 \equiv 4Na_2S_2O_3$, or, in other words 1 ml. of 0.1N thiosulphate corresponds to 0.005955 gm. of uranium. For a quantitative precipitation of uranyl selenite regulation of pH of the medium is an important factor. Its adjustment between 4 to 5 was readily achieved by running in a requisite amount of 5 per cent ammonium acetate solution. It was observed that in purely aqueous medium, uranyl selenite tends to hydrolyse appreciably. To prevent this an excess of absolute alcohol was added to the uranyl sulphate solution and its overall content was kept at or about 50 per cent. It may be mentioned that besides its simplicity and accuracy the present method affords a convenient means of estimating hexavalent uranium directly by H_2SeO_3.

II. *Application of Cerium (IV) in Volumetric Analysis*—Compounds of tetrapositive cerium are at present the most versatile and useful group of volumetric oxidising agents. Their increasing popularity is due to many reasons : (i) They are powerful oxidants (oxidation potential 1·4—1·8). (ii) Ceric sulphate solutions are remarkably stable when kept for several months or even when boiled for a few hours. (iii) They can be used in presence in hydrochloric acid. (iv) Ferroin (o-phenanthroline ferrous complex) is available as an excellent indicator in ceriometric titrations. (v) Owing to simple and clear-cut valence change, $Ce^{+4} + e \rightarrow Ce^{+3}$, the presence of other trivalent

rare earths—the usual congeners of cerium—does not affect the accuracy of the results. Thus ceric sulphate has almost supplanted $KMnO_4$, $K_2Cr_2O_7$ and other oxidising agents frequently used in quantitative analysis. It has been employed here as an oxidant for thiocyanate and for an indirect determination of thiourea.

7. *Oxidation of Thiocyanate by Ceric Sulphate*—The ease of formation of thiocyanate complexes and the facile oxidation of sulphur to sulphate form the basis of numerous methods of estimating thiocyanate (Furman, J. Amer. Chem. Soc., 50, 1322, 1928; Lang, Z. anorg. Chem.; 142, 280, 1925; Manchot and Oberhauser, ibid., 130, 161, 1923; Prodinger, 'Organic Reagents used in quantitative Inorganic Analysis). Despite numerous attempts the quantitative oxidation of thiocyanate by ceric sulphate could not be achieved and the scope of this reaction was restricted to an indirect determination of cerium (Deshmukh and Sant, Proc. Ind. Acad. Sci., 37, 504, 1953). At an early stage it was observed that KCNS can be oxidised completely on boiling with an excess of ceric sulphate. Based on this a titrimetric method for the estimation of KCNS has now been developed.

To a known excess of standard ceric sulphate solution, an aliquot portion (10 ml.) of KCNS was added with constant stirring followed by an adequate amount of conc. H_2SO_4 to increase the total acidity of the system to about 6N. It was then boiled gently for about 15 minutes till the odour of HCN was imperceptible. The flask was then cooled to room temperature and the excess $Ce(SO_4)_2$ was back titrated against standard Mohr's salt solution using ferroin as indicator. The difference in the initial and back titre values showed the amount of ceric sulphate consumed for the oxidation of KCNS in accordance with the following equation:

$$6Ce(SO_4)_2 + KCNS + 4H_2O \rightarrow 3Ce_2(SO_4)_3 + KHSO_4 + H_2SO_4 + HCN.$$

The results obtained are in close agreement with those from the classical Volhard's procedure. In the present method the high molecular weight of ceric sulphate and ratio $6Ce(SO_4)_2 \equiv 1KCNS$ offer a special advantage for estimating very small quantities of thiocyanate.

8. *Determination of Nickel, Cobalt and Cadmium*—Cobalt, nickel and cadmium in the divalent stage form sparingly soluble thiocyanate complexes in conjunction with pyridine base. In the actual procedure the excess thiocyanate is estimated by the Volhard's procedure (A. I. Vogel, 'A Text-Book of Quantitative Inorganic Analysis' pp. 323-324). This method is now modified by employing $Ce(SO_4)_2$ for the determination of excess KCNS.

0.05—0.1 gm. of Co(ous), Ni(ous) or Cd salt is dissolved in 150 ml. water in a 250 ml. standard flask. 2 ml. of pure pyridine and a measured excess of KCNS are now added and the solution made up to the mark. The precipitated metal-pyridine-thiocyanate complex was filtered through Whatman no. 42 and the excess thiocyanate in its aliquot portion treated with an excess ceric sulphate solution. The system was boiled for 15—20 minutes in presence of about 6N H_2SO_4, cooled, and the excess oxidant titrated against standard Mohr's salt solution using ferroin indicator. From the knowledge of blank

KCNS-Ce $(SO_4)_2$ reaction, the thiocyanate reacted with cobalt, nickel or cadmium in terms of $Ce(SO_4)_2$ was calculated. This served as a direct measure of the quantity of these metals. The results obtained were found to agree well with the standard Volhards'.

9. *Estimation of Thiourea*—Preliminary experiments showed that when an aqueous solution of thiourea was added to a measured excess of ferricyanide solution in presence of NaOH, $(NH_2)_2CS$ was oxidised quantitatively to urea and sulphate with simultaneous formation of ferrocyanide. In the actual procedure, thiourea is estimated by titrating the ferrocyanide formed in HCl or H_2SO_4 medium against standard $Ce(SO_4)_2$ using ferroin or 1—2 drops of $FeCl_3$ (towards the end) as indicator. The following reactions take place :

$$8K_3Fe(CN)_6+8KOH \longrightarrow 8K_4Fe(CN)_6+4H_2O+2O_2 \quad \text{(i)}$$

$$CS(NH_2)_2+2O_2+H_2O \longrightarrow CO(NH_2)_2+H_2SO_4 \quad \text{(ii)}$$

$$2K_4Fe(CN)_6+2Ce(SO_4)_2 \longrightarrow 2K_3Fe(CN)_6+Ce_2(SO_4)_3+K_2SO_4 \quad \text{(iii)}$$

The volume of ceric sulphate equivalent to $K_3Fe(CN)_6$ corresponds directly to the amount of thiourea present in the system. The method is found to yield fairly accurate results. These have been further verified by determining the excess $K_3Fe(CN)_6$ iodometrically in terms of standard sodium thiosulphate and/or arsenious oxide.

III.

10. *Volumetric Determination of Cerium by $KMnO_4$*—A volumtric method for the determination of KCNS depending on its quantitative oxidation by $KMnO_4$ in presence of ICl catalyst was reported earlier from these Laboratories (Deshmukh and Joshi, Z. anal. Chem., 142, 275, 1954). In this procedure a standard solution of permanganate was added slowly to thiocyanate solution in 1.5 to 2N HCl medium and the end point was noticed by the sudden disappearance of iodine colour in the carbon tetrachloride layer.

Earlier observation showed that KCNS reduces ceric sulphate quantitatively to the cerous condition and cerium may be determined by titrating the excess thiocyanate indirectly by the Volhard's procedure (Deshmukh and Sant, Proc. Ind. Acad. Sci., 37, 504, 1953). This method was, however, tedious and found to be impracticable in presence of HCl and other ions which generally interfere in argentometry. These observations emphasised the necessity of modifying the above procedure in the light of KCNS-$KMnO_4$ reaction. Cerium in ceric sulphate has now been estimated by standard permanganate.

To an aliquot volume of ceric sulphate solution taken in an Erlenmeyer flask, a measured excess of standard KCNS was added with constant swirling till the yellow colour of Ce^{iv} was discharged completely. A requisite quantity of HCl to maintain its overall normality in the system between 1·5-2N was now introduced followed by 10 ml. of iodine monochloride and 5 ml. of carbon tetrachloride. A standard solution of $KMnO_4$ was run in with constant shaking of the solution till the iodine (violet) colour from the organic solvent was

discharged completely. This usually coincided with the appearance of pink colour of permanganate in the aqueous layer. The difference in the initial and final titre values of $KMnO_4$ corresponds to the amount of Ce according to the following equations :

$$5KCNS + 6KMnO_4 + 12H_2SO_4 \rightarrow 11KHSO_4 + 6MnSO_4 + 5HCN + 4H_2O \text{ (i)}$$

$$6Ce(SO_4)_2 + KCNS + 4H_2O \rightarrow 3Ce_2(SO_4)_3 + KHSO_4 + HCN + 3H_2SO_4 \text{ (ii)}$$

Therefore $6Ce(SO_4)_2 \equiv 1KCNS \equiv 6/5\ KMnO_4$, or, 1 ml. of 0.1N $KMnO_4$ = 0.01401 gm. Ce.

These results are in excellen t agreement with those obtained by the standard procedure. Since the above method depends upon oxidation reduction reactions, other trivalent rare earths—the familiar contaminants of cerium do not affect the accuracy of the results. The present method of cerium estimation by permanganate is simple, accurate and applicable over a wide range of experimental conditions.

5. *Research Workers*—Dr. J. D. Tewari and Dr. A. L. Misra, Chemistry Department, University of Allahabad.

Research Project—Studies in thiamine analogues and substitutes—

Papers published—

1. *'Chemische Berichte'*—Vol. 86, 857 (1953).

2. Notiz iiber ein neues Reagent zum Nachweis von Nitrit-Ion, *Z. anal, Chemie*, 89, 139, (1953).

On the basis of formulation of thiamine as a peculiar quarternary thiazolium salt and the observation that β-(4 methylthiazolyl 5) alanine may be a possible precursor of thiamine, together with the activity (and α-hydroxy pyridine and 2 : 6 dihydroxy quinoline have physiological properties similar to those of thiamine but less pronounced) experiments were started to explore the possibility of the existence of some such substitutes which may have a measurable Vitamin activity. In this connection 2-amino 4-chloromethylthiazole hydrochloride has been made to condense with certain heterocyclic nuclei as pyridine, quinoline, isoquinoline under certain conditions.

These condensations were carried out at various temperatures between 35° and 100°C. and the temperature suitably adjusted to give the maximum yield. The two products, i.e., of pyridine and isoquinoline are obtained in good yield but that of quinoline in poor yield. The resulting mother liquor from the quinoline condensation is of beautiful red colour. The poor yield may probably be due to the side-reactions of the quaternary compound with itself as in the case of cyanine and isocyanine dyes.

These heterocyclic quaternary compounds show promise for being tested as growth promoting substances. In view of such property possessed by some recently tested aminothiazole and aminothiazoline derivative.

A detailed report on this work appears in a paper entitled "Some quaternaryammonium salts of heterocyclic bases with 2-amino 4-chloromethyl thiazole" in Chemische Berichte.

In the above attempt it was intended to study the fact that the amino group in position 2 of the thiazole nucleus may have some growth promoting activity and the modification of that activity by substitution in position 4 of the same nucleus by compounds possessing a reactive thiol (—SH) grouping in the molecule as thiourea, thiosemicarbazide and cysteine hydrochloride.

Condensation with thiosemicarbazide (1 mol.) and the 2-amino-4-chloromethyl thiazole hydrochloride (1 mol.) was carried out in a boiling water bath by taking up the requisite thiosemicarbazide in boiling 90 per cent rectified spirit till most of it is dissolved and then adding the requisite thiozole. The mixture is kept boiling on the bath with vigorous stirring. After about fifteen minutes, a white crystalline condensation product separates out during the process of heating as a result of an exothermic reaction. Boiling is continued for another hour and then contents are cooled and the crystalline matter filtered out and recrystallised from dilute alchohol in quantitative yield. This product has been condensed with aromatic aldehydes such as para-dimethylaminobenzaldehyde, benzaldehyde, cinnamaldehyde, salicylaldehyde, etc. to give crystalline products which are being worked out. A detailed report will be communicated for publication as soon as ready.

The condensation of the 2-amino-4-chlormethylthiazole hydrochloride with cysteine hydrochloride to yield a substituted methionine derivative is specially interesting, but the yield of the condensation product is very low, and hence the attempt was made to condense them in cold. In order to increase the yield of the resulting product, this synthesis was modified using s-(2-amino-4-thiazolyl methyl) iso-thiourea and α-amino β-chlromethylpropionic ester hydrochloride. The results of this condensation which is being worked out will be communicated as soon as they are completed.

On similar lines, the condensation of the original 2-amino-4-chloromethylthiazole with 2-aminopyridine, para-aminobenzoic ethylester (benzocaine) have also been done to study the effect of these nuclei when present in conjunction with the above aminothiazole. It has been found that the character of the amino group of thiazole nucleus with respect to its reaction with acetyl sulphanyl chloride, changes and the condensation reaction with the latter compound is inhibited. An attempt has also been made to assess the suitability of some of the thiazole substituted compounds in analytical chemistry for the detection of NO_3 ions and (2-amino-4-thiazolylmethyl) isothiouronium hydrochloride as a possible reagent for the organic fatty acids.

6. *Research Workers*—Dr. A.K. Bhattacharya and Sri Tara Chandra Gupta, Agra College, Agra.

Research Project—Volumetric estimation of iron in natural ores by potassium permanganate in presence of hydrochloric acid.

The workers have been able to study the redox equilibrium of potassium permanganate in presence of sulphuric and hydrochloric acids by potentiometric method. The work is also in progress on the redox equilibrium of the system in presence of manganese sulphate and phosphoric acid with a view to study their role in improving the results of titration in presence of hydrochloric acid.

7. *Research Workers*—Prof. S. Ghosh and Dr. Prem Behari Mathur, Chemistry Department, Allahabad University.

Research Project—Studies on periodic precipitation.

Papers Published—(1) Mathematical theory of Liesegang ring based on the phenomenon of restricted diffusion (Kolloid-Z.).

(2) A mathematical theory of chromatography and modification of diffusion method of isotopic separation.

(J. Sci. Industr. Res., December, 1955).

Liesegang rings are generally distinguished on the basis of void spaces and continuous bands of different colours. This classification does not cover the characteristics of different ring systems so far observed. Ring systems have, therefore, been classified in three different ways on the basis of:

(*a*) comparative distances between the successive rings,

(*b*) large and small magnitude of the bands, and lastly,

(*c*) void space appearance or continuous deposition of alternate coloured bands.

These classifications have been analysed in the light of diffusion wave theory for Liesegang rings which has been advanced by mathematical treatment of diffusion through a multi-component system. The equation derived is able to explain the different kinds of periodic precipitation as classified above. Experiments have also been carried out for confirming the theoretical conclusions. A separate study has also been made to investigate the effects of several physical and chemical factors viz., pressure, potential, solubility product, colloid formation, etc. leading to the formation of Liesegang rings.

The growth of rings has been studied and it was found that finer structure in precipitates of the rings is a characteristic feature of Liesegang systems. In some cases, however, it is disturbed due to the unsuitable environments. The theoretical analysis and experimental work to examine several other aspects of the phenomenon are under investigation.

The authors have also given a mathematical treatment of diffusion of electrolytes to explain various types of periodic precipitations. The diffusion equation is

$$\frac{dc}{dt} = D\frac{d^2c}{dx^2} + Kdc + K_1C$$

The solutions of the above equation have also been given and it has been pointed out that the zeta-potential of the gel medium and also the zeta potential of the banded precipitates play an important role in periodic precipitation. Further experimental work is in progress to verify the theoretical diffusion equation.

8. *Research Workers*—Dr. P. N. Bhargava and Sri Ravindra Pratap Rao, Chemistry Department, Banaras Hindu University, Varanasi.

Research Project—Chemical examination of *Alangium Lamarcki*.

The various parts of the seeds of Alangium Lamarckii have been chemically examined. The percentage of moisture and ash in the seeds shell has been determined. Elements in the shell ash have been detected and the presence of phosphorus, chlorine, iron, aluminium, calcium and magnesium has been confirmed. Further the crushed shell powder has been extracted successively with the following solvents for 5 hours to 7 hours in a Soxhlet extractor and the extracts dried at 100°C.

The alcoholic and aqueous extracts gave the test of sugars, the percentage of the sugar content being greater in the latter. The sugars were detected by Twitchell's lead salt extraction method and the experiments repeated several times till concordant values were obtained The benzene and chloroform extracts answered the colour reaction of phytosterols. The study of the various properties and preparation of derivatives of the substance awaits its further purification.

The seed-kernels were obtained by crushing the seeds and by the laborious process of hand-picking. After being crushed, they were extracted with benzene, under reflux for 14 hours to 21 hours, in most cases the mass obtained after distillation and evaporation of the solvent was resinous and dark brown in colour. It was washed several times with petroleum ether and the residue after several crystallizations with dry benzene gave a slight yellowish white product melting at 385-296°. This accounted for various characteristic colour reactions of 3-β sterol. In an alternative method the powdered seed-kernals were first extracted with petroleum ether, so as to remove the resinous matter and the remaining mass was further extracted with benzene, when again a product similar to that extracted previously was obtained melting at 286°.

In most cases the extract obtained was dark in colour. It was then refluxed for 4 hours with 1/10 its weight of powdered animal charcoal. The extract was then filtered out; some charcoal passed through the filter paper, being in a highly fine state. The charcoal on the filter paper was taken up with fresh benzene and refuxed for two hours and filtered. The filtrate was mixed with the original filtrate (filtered extract). This was then refiltered 2-3 times to remove the last traces of animal charcoal. The final filtered extract was light yellow in colour. The extract was distilled to remove the major portion of the solvent. The concentrated extract was cooled when yellowish white crystals appeared. They were separated by decanting the mother liquor. The crystals were washed thrice with fresh dry benzene, adding the washings to the mother liquor. The crystals were thus obtained nearly white with a slight yellowish tinge.

9. *Research Worker*—Dr. Vinay S. Misra, Chemical Laboratories, Lucknow University, Lucknow.

Research Project—Chemotherapy in tuberculosis.

Papers published—'Possible Anti-tuberculous Compounds' by Misra and Khare.

Part I	Journ. Ind. Chem, Soc.	29, 695, 1952.
II	Ditto	30, 43, 1953.
III	Ditto	31, 329, 1954.
IV	Ditto	31. 918, 1954.
V	Ditto	33, 153, 1956.

A quite large number of potential anti-tubercular compounds were synthesised and tested *in vitro*. Three of these compounds were found to be as active as P. A. S. and I. N. H. (Isonicotinic acid hydrazide). The importance of fighting the scourge of tuberculosis need not be mentioned; any drug which could materialise out of these researches would be a boon for the suffering humanity.

10. *Research Workers*—Dr. N. K. Basu, Department of Pharmaceutics, Banaras Hindu University.

Research Project—Chemical and pharmacological investigations of the alkaloids of *Convolvulus pluricaulis*.

Convolvulus pluricaulis—Chois N. O. Convolvulaceae (Sanskrit and Hindi Sankhapuspi) is used as a brain tonic and in the treatment of some forms of insanity by physicians practising Indian systems of medicine. The drug investigated is different from *Evolvulus alsinoides* (N. O. Convolvulaceae) and from *Canscora decussata* (N. O. Gentianaceae). The name 'Sankhapusi' has also been ascribed to the latter two drugs and there is some confusion amongst physicians.

The present worker previously reported the presence of an alkaloid $C_{17}H_{23}NO_3$ and an essential oil. During the present investigations several sterols were isolated. Their properties are given in the table below :

Constants	1st crystalline sterol	2nd low melting sterol	3rd crystalline sterol
Melting point ...	124°—125°	...	64°
Boiling point ...	...	114°—115°	...
Empirical formula ...	$C_{11}H_{18}O$	$C_{21}H_{32}O$	$C_8H_{12}O$
Molecular weight ...	221·8	2:3·3	629·2
Digitonite derivative m p.	224°	214°	84°—85°
Acetyl derivative m. p.	117°	b. p. 167°—168°	88°

Pharmacological studies on the base chloroform soluble reported before showed that it did not lower the blood pressure but the heart was arrested for sometime, which becomes normal when the drug is washed out.

Two further basic substances Base A—$C_5H_{11}NO,2H_2O$ and Base B—$C_5H_9NO,_2H_2O$ have been isolated from the alkoholic extract of the whole plant. The basic substances were taken up in 3 per cent H_2SO_4 by shaking the concentrated alcoholic extract and precipitated as their reineckate complex. The reineckate complexon further conversion into total hydrochloride and that on chromatography over alumina yielded at least three basic substances. Aaong them two were obtained in pure form and characterised further. Base 'A' was found to contain one hydroxyl group. Distillation with soda-lime yielded n-propylamine and a tertiary amine which could not be identified. On oxidation with alkaline permanganate it yielded a base, later identified as Base 'B' itself. I. R. spectrum of the isolated bases was also studied.

The Base 'A' was found to be pharmacologically active. It lowered the blood pressure of an anaesthetised dog. It also exhibited a temporary inhibitory action on pithed frog's heart and caused contraction of plain muscles. The Base 'B' was found to be rather inactive.

11. *Research Workers*—Dr. L. N. Mukerjee, and Sri Suraj Narain Srivastava, Chemistry Department, Lucknow University, Lucknow.

Research Project—Systematic studies on solid emulsifying agents with special reference to hydrous oxides and hydroxides of metals.

Papers published—

(1) Finely divided solids as emulsifiers, Part I, Emulsions stabilised by hydroxides and hydrous oxides of metals. (Kolloid-Z. 147, 146—152, 1956).

(2) Finely divided solids as emulsifiers Part II Emulsions stabilised by basic salts of metals (Kolloid-Z. 119, 35-38, 1956),

(3) Finely divided solids as emulsifiers Part III Emulsions stabilised by miscellaneous solids (Kolloid-Z 150, 144-148, 1957).

(4) Bordeaux mixture and related compounds as emulsifiers. (Kolloid-Z. 150, 148—151, 1957).

In this work a wide variety of finely-divided solids has been used as emulsifiers and graded according to their efficiency, to promote emulsification A quantitative measure has been assigned to the stability of emulsion and respective stabilities have been measured by the size frequency technique. A quantitative comparison of the stabilities of various emulsions stablised by solid agents have also been made. For the sake of convenience, the various solids have been divided into three groups: (1) hydrous oxides and hydroxides of metals, (2) basic salts of metals, and (3) miscellaneous solids such as clays, sulphates, carbonates and oxychlorides of common metals. An additional chapter includes Bordeaux mixture and related compounds as emulsifiers. Attempt has also been made to connect the stability of the emulsifier with its wetting power.

Iron, chromium and aluminium compounds were especially efficient and should have some use in industry, while mercury and lead precipitates might also have specific uses in pharmacy. Last but not the least important is copper hydroxide with Bordeaux mixture and related compounds; which have got additional value as fungicide; these coupled with some phosphates, arsenites and arsenates should have extensive utility in insecticide-fungicide realm.

12. *Research Workers*—Dr. Sadgopal and Sri S.A. Narang, Forest Research Institute, Dehra Dun.

Research Project—Preparation of phenylhydrazine derivatives of some fatty acids.

Papers published—(1) Indian Soap Journal, Vol. 23. p, 10, (1957).

The investigators carried on work on the reaction of phenylhydrazine with a number of acids and found that in most of the cases a white crystalline compound is formed very readily. They further found that benzene fails to carry out the precipitation of the phenylhydrazide of the fatty acids and therefore, they have replaced it successfully by petroleum ether. The modified method that was used had the advantage that the reaction could be completed within 20 minutes and as small a quantity as 0·05g. of the acids can be used for their identification. The authors have reported the melting points and N per cent of derivatives of the following fatty acids formed with phenylhydrazine :

1. Pelargonic acid.
2. Arachidic acid.
3. Behenic acid.
4. Cerotic acid.
5. Oleic and.
6. Linoleic acid.
7. Dihydroxystearic acid.
8. Tetrahydroxystearic acid.
9. Hexahydroxystearic acid.
10. Azelaic acid.
11. Rucinoleic acid.
12. Chaulmoogric acid.

13. *Research Workers*—Dr. I. K. Taimni and Sri Manohar Lal, Chemistry Department, University of Allahabad, Allahabad.

Research Project—A comprehensive scheme for the systematic detection of anions.

A new and comprehensive scheme for the systematic detection of anions has been put forward, as no such scheme was available so far. The scheme is based on the precipitation of difficultly soluble salts of anions in groups by different basic group reagents in sodium carbonate solution and the subsequent analysis of each group precipitate or filtrate for the detection of individual members of the group.

The basic group reagents used successively are :

(*a*) Lead carbonate.

(*b*) Zinc nitrate or acetate.

(*c*) Cadmium nitrate.

(*d*) Calcium nitrate.

(*e*) Barium nitrate.

(*f*) Silver nitrate.

This scheme also includes the well known acids like, phosphite, hypophosphite, bromate, iodate, periodate, perchlorate, the rare-elements in their acid forms, e.g. tellurite, tellurate, selenite, selenate, molybdate, vanadate, tungstate and other basic radicals which pass into the sodium carbonate extract owing to their amphoteric nature or the formation of complexes with ammonia and sodium carbonate. The list of acids included in the scheme is given below ;

Sulphide, vanadate, ferricyanide, ferrocyanide, arsenite, arsenate, phosphite, phosphate, tellurite; tellurate, borate, periodate, fluoride, oxalate, selenite, molybdate, chromate, tungstate, sulphite, silicate, aluminate, beryllate, antimonate, antimonite, stannate, stannite, thio-sulphate, selenate, iodate, chloride, bromide, iodide, sulphate. chlorate, bromate, hypophosphite, thiocyanate. permanganate, perchlorate and complexes of uranium, copper, cobalt, nickel, zirconium and thorium. Only tests for carbonate, nitrite, acetate and borate are not provided in this scheme.

14. *Research Workers*—Dr. A. C. Chatterji and Sri Ram Naresh, Chemistry Department, Lucknow University, Lucknow.

Research Project—Investigation of nucleation phenomenon.

The aim of this series of investigations has been to study the kinetics of crystal nucleation from solution and development of experimental techniques. The study of nucleation kinetics is greatly disturbed by the fact—

(1) that it is difficult to prepare solutions that are free from minute solid heterogeneities—working as nucleation catalyst, and also,

(2) that, as soon as a nucleus is formed, crystallisation by the growth process proceeds quite rapidly, ending the pure nucleation experiments.

The nucleation and growth of crystallites of KCl, KBr, KI, NH_4Cl, NH_4 Br, NH_4I in their quite supersaturated aqueous solutions have been investigated using electrical conductivity measurements at 35°C$\pm$0·002°C. The sensitivity of the conductivity apparatus working on Callendar and Griffith's Bridge principle being ·0004 per cent. under the experimental conditions.

The time θ required for the formation of nuclei in the bulk of the solution is in fair agreement of the relation $\log \theta \propto 1/\log^2 (X/Xo)$, where X and Xo are mole fractions of solute in the supersaturated and saturated salt solutions at 35°C, respectively.

Various thermodynamic constants including activation energies, surface free energies and size of crystal nuclei have been calculated from experimental results in each case.

15. *Research Workers*—Prof. P. I. Itiyerah and Sri Abraham Thomas, Chemistry Department, St. John's College, Agra.

Research Project—Synthesis of certain hetero-cyclic detoamines and their derivatives : some with possible analgesic activity and others with possible photosensitising property.

It was found by the authors that the methods recommended by Braunholtz and Mann were the best for cyclisation of the cyanoethyl derivatives. Aniline and m-toluidine were cyanoethylated, It was noted that the quality of cuprous chloride used exerted considerable influence on the yield of the products.

Dicyanoethylation of p-thiocyanoaniline was tried. It was found that the reaction did not go under the conditions observed.

From the dicyanoethyl products obtained from aniline and m-toluidine, several diazo compounds were prepared. These compounds whose names are listed below have been prepared for the first time. They have been qualitatively and quantitatively analysed. They are brightly coloured substances and the use of some of these as indicators is under investigation. The diazo compounds prepared and identified are :

1. 4 : NN-Bis-cyanoethylamino -azobenzene.
2. 4 : NN-Bis-cyanoethylamino-2-methyl azobenzene.
3. 4′ : Bromo-4-NN-bis-cyanoethylamino-2-methyl azobenzene.
4. 2′ : Carboxy-4NN-bis-cyanoethylamino-2-methyl-azobenzene.

Here mention may be made of the failure in the attempts to couple diazotised p-bromoaniline, sulphanilic acid and anthranilic acid with NN-bis-cyanoethylaniline. Diazotised sulphanilic acid coupled with NN-bis-cyanoethyl-3-methylaniline giving lustrous orange crystals of the sodium salt but analytical figures obtained for nitrogen are lower than the expected figure.

NN-bis-cyanoethylaniline readily formed the para. nitroso derivative. Attempts to reduce the C-nitroso group are being made.

The two bis-cyanoethyl derivatives obtained from aniline and m-toluidine were cyclised in presence of anhydrous aluminium chloride using chlorobenzene and o-dichlorobenzene as the respective solvents. I Braunholtz and Mann, loc. cit. ï . 1: 6—Dioxoju lolidine and 7—methyl—1 : 6—dioxojulolidine were obtained.

1 : 6—Dioxojulolidine was then condensed with benzoyl-acetonitrile. From this reaction 1 : 6-bis-[benzoylcyanomethylene]—julolidine was isolated. This substance has all the structural requirements of a cyanine. Its light absorption and photosensitising properties are to be investigated.

7-Methyl-1 : 6-dioxojulolidine was dehydrogenated using palladised charcoal. The solvent used was p-cymene. On extraction 7-methyl-1 : 6-dioxo-isojuloline was obtained. Several derivatives like the picrate, hydrobromide and the perchlorate were prepared. A structure has also been proposed.

16. *Research Workers*—Dr. R. H. Sahasrabudhey and Sri C. N. V. Nambudiri, Chemistry Department, Banaras Hindu University.

Research Project—Chemistry of organic disulphides.

The immediate object of the work was to prepare compounds with a S-S bridge, related to oxyacids of sulphur. It is intended to study the general behaviour of these compounds, with respect to (i) the stability of S-S link, and (ii) the mobility of oxygens joined to sulphur.

Part I—Preparation of alkali tetrathionate and its subsequent benzylation were tried, but no benzyl derivative was obtained.

Benzylation of thiosulphate (which has been done by earlier workers) was carried out and sodium benzyl thiosulphate was obtained. This reaction has now been studied under a restricted variety of conditions. The yields are very good at ordinary temperature in aqueous medium using excess of benzyl chloride.

Benzylation of sodium hydrosulphite (dithionite) was carried out under analogus conditions. No benzyl ester of this acid could be obtained, but surprisingly enough it gave sodium benzyl thiosulphate which was identified with an authentic sample prepared above, directly from the thiosulphate. The yield roughly accounted for only less than half of the original sulphur. Work is in progress to establish the mechanism of this very interesting reaction.

Part II—The oxidation products of disulphides are intended to be studied. Products with oxygen atoms loaded on sulphur can be obtained in two ways : (i) Direct oxidation, controlled or otherwise, with different reagents ; (ii) synthesis.

For the latter, sulphonyl and sulphinyl chlorides are needed as intermediates. The sulphonyl chlorides can be obtained relatively easily and are well known. Practically no work exists on the sulphinyl chlorides. Only one or two compounds of this series have been prepared but their properties have not been studied. They have been prepared through the following series of changes :

$$\underset{}{RSO_2H} \xrightarrow[1]{} \underset{}{RSO_2Cl} \xrightarrow[2]{} \underset{}{RSO_2H} \xrightarrow[3]{} RSOCl$$

The yields at stages 2 and 3 are extremely bad and compounds are extremely reactive and, therefore, every now and then only a small quantity can be obtained.

It was expected that naphthalene sulphinyl chloride might have a reasonably high m. p. and stability. Experiments were undertaken to prepare it by the above series of changes.

α or β naphthalene sulphonic acids or their salts were not available commercially and therefore, recourse had to be taken to prepare sodium salt of β naphthalene sulphonic acid in the laboratory. Though this meant considerable time, it was relatively easily obtained. Its conversion into the sulphonyl chloride gave 80 per cent yields but greate t difficulty was encountered in its reduction to sulphinic acid. Sincse details are lacking in the literature, experiments had to be undertaken under various conditions. The yields of crude sulphinic acid are around 20—30 per cent only. Interaction of this substance with thionyl chloride under various conditions and proportions of reactants, were undertaken with a view to obtain the corresponding RSOCl. Amongst the products, sulphonic acid, sulphonyl chloride and unidentified sticky residues were obtained. It is not yet clear whether the sulphinyl chloride is formed or not. Experiments are in progress.

Part III—In the work connected with Part II above sulphinic acids are required either for preparatory purposes or one comes across them as products of derangements. These substances are very unstable and at times the melting points of related products are fairly close to their own melting points. Some procedure, therefore, was necessary for identifying them rapidly. Preliminary experiments with Donlevy's reagent have given encouraging results The m. ps. of these derivatives are sharp and quite high and besides they crystallize well.

17. *Research Worker*—Dr. Krishna Bahadur, Chemistry Department, University of Allahabad.

Research Project—Photosynthesis of amino acids from paraformaldehyde and potassium nitrate.

The author has investigated the optimum conditions for the photosynthesis of aminoacids from a mixture of paraformaldehyde, potassium nitrate and water. He has investigated the influence of hydrogen ion concentration of the medium on the nature of amino acids formed and has observed that at pH value 5·5 and 5, glutamic acid is sythesised first but when the pH of the medium is 3, 2·5 and 2 lysine is first formed. He has also investigated the subsequent formation of other amino acids and has observed that as the period of exposure increases new aminoacids appear. However, a few of the previously formed amino acids disappear and they are probably utilised in the synthesis of other amino acids The author has also studied the mechanism of formation of a number of amino acids as aspartic, glutamic, arginine, lysine, histidine, glycine, alanine, valine and leucine, and has observed that a few of these amino acids combine to form polypeptides. The author has further observed that even if a suspension of paraformaldehyde and water and molybdenum colloid is exposed to artificial electric light of 500 watts. lamp and a mixture is sterlised before exposure and kept well sterilised during the exposure, a number of amino acids are synthesised in the mixture whose presence can be tested by a ninhydrin test employing paper chromatography. The author is of the view that this is probably due to the fixation of atmospheric nitrogen which is caught by the radicals of carbon chain formed by the decomposition of paraformal-dehyde on irradiation with light.

18. *Research Workers*—Prof. Bawa Kartar Singh and Sri Bhupendra Sahai Saxena, Banaras Hindu University, Banaras.

Research Project—Rotatory dispersion of p-sulphonamido-phenyl-amino-d-camphor.

This work has been divided into two parts. The first part includes some preliminary work of preparation of a few compounds on which work has been going on in this laboratory and also the study of their physical properties like rotatory dispersion, refractive dispersion and the absorption spectra. The second part includes the research work proper.

(*a*) Following compounds were prepared :

d—and *dl*—camphor—*β*—sulphonic acid.

d—and *dl*—camphor—*β*—sulphonyl chloride.

d—and *dl*—camphorquinones.

d—camphor—*β*—sulphonyl—phenylamide.

d—camphor—*β*—sulphonate of ortho bromoaniline.

(b) Sulphur and nitrogen were quantitatively estimated in some of the above compounds ; the results agreed with the calculated values.

(c) Rotatory dispersion of *d*—camphor—*β*—sulphonyl—phenyl amide was studied in seven solvents for 13 lines. The results agreed, within experimental error, with those already published by B. K. Singh and S. M. Verma.

(*a*) Following compounds were prepared.

(i) *p*—amino—benzene—sulphonamide was condensed by heating at 120°—140°C in equimolecular quantities with *d*—and *dl*—camphorquinones in presence of anhydrous sodium sulphate.

The *p*—sulphonamido—phenylimino—*d*—camphor was obtained in yellow needles melting at 222°C if heating was slow but melted at 228° C on rapid heating. (Reported by B. K. Singh and M. S. Manhas m. pt. is 228°C).

Found N_2=9·08 ; calculated for the formula $C_{16}H_{20}N_2SO_3$=8·75 per cent.

Found S=9·79 ; Calculated for the formula $C_{16}H_{20}N_2SO_3$=9·94 per cent.

The *p*—sulphonamide—phenylimino—*dl*—camphor was obtained in fine yellow leaflets melting at 227·4°C (Reported melting point by B. K. Singh and M. S. Manhas=240°C).

Found N_2=8·93 per cent ; Calculated for the formula $C_{16}H_{20}N_2SO_3$=8·75 per cent.

(ii) The above *d* and *dl*—imino compounds were reduced with KOH and zinc dust and the reduced product crystallised from alcohol.

p—Sulphonamido—phenylamino—*d*—camphor has the melting 180·4°C while the *dl*—isomer melted at 162°C.

(iii) Other sulpha drug (sulpha-thiazole, sulpha-pyridine and sulpha merazine) were condensed with *d*—camphor-quinone by the above method. Heating even upto 160°C did not produce any result in the case of sulpho thiazole and sulpha-merazine, but some reaction appeared to have taken place in the case of sulphapyridine as indicated by the whole mass acquiring a pasty consistency. After repeated recrystallisation of this hardened pasty substance only a very small quantity (about 0·4 per cent yield) of a yellow crystalline substance melting at 195°C was obtained. It remains to be confirmed if this is the required condensation product.

(*b*) Rotatory dispersion of *p*—sulphonamido—phenylamino—*d*—camphor has been taken in three solvents for thirteen wavelengths.

(*c*) The mixed melting point-composition diagram of *d*-and *dl*-isomers of *p*-sulphonamido-phenylimino-*d*-camphors has been prepared.

19. *Research Workers*—Dr. M. S. Bhatnagar and Sri L. M. Joshi, Harcourt Butler Technological Institute, Kanpur.

Research Project—Sulphonation of organic compounds and production of synthetic tannins.

The preparation of synthetic tannins or 'syntans' depends basically on the sulphonation of some high polymers phenolformal dehyde resins on which sulphonation exhibits what is termed as Tanning property. Similarly other phenol alcohols give the same property. It has also been found that aromatic hydrocarbons (with two or more benzene rings) when sulphonated and condensed with aldehydes, give tanning property.

Hence, the first phase, in the preparation of these compounds is to prepare condensed high polymers with aldehydes in general and formaldehyde in particular. The polymers which were prepared and sulphonated are :

1. Phenol-formaldehyde resins.
2. Cresol-formaldehyde resins.
3. Urea-formaldehyde resins.
4. Naphthalene-formaldehyde resins.

1. *Panol-formaldehyde resins*

Condusing agent	Colour of the resin	Amount of the agent on the weight of the phenol	Temp.
Sodium carbonate ...	Red ...	10 per cent	95—100°C.
Potassium bi-sulphite ...	Whitish red ..	5 per cent	100°C.
13 per cent N_aOH solution.	Red	10 per cent	110°C.
30 per cent ammonia solution.	Yellow ..	15 per cent	110—120°C.
10 per cent H_2SO_4 solution.	Milky white...	10 per cent	110°C.

The excess of phenol is advisable since, otherwise, formaldehyde itself shall condense thereby reducing the efficiency of the mechanism. Stirring is necessary during condensation.

For sulphonation, 95 per cent conc. H_2SO_4 can be used but oleum (14—20) per cent SO_3 contents) is preferred for uniform and rapaid progress in the reaction.

During condensation care must be taken that the process is stopped at the stage where it gives a water soluble product. This is acquired only after practice.

Another method used is to sulphonate phenol with sulpheric acid till sulphonation is complete and to neutralise the excess of acid with sodium bicarbonate to such an extent that—

1 c.c. of the phenol sulphonic acid=10 c.c.s. of 0·1 NaOHSol.

After that the sulphonic acid is condensed with formaldehyde up to the stage where it is water soluble. Excess of formaldehyde, thought does not harm the tanning property, is driven away by heating at 100—105°C.

Similarly cresol base syntans urea formaldehyde sulphonated resins have also been prepared.

Nepthalene base sulphenated resins have also been successfully prepared.

For condensing naphthalene sulphonic acid with formaldehyde isomer of the acid is used which is prepared by heating naphthalene with oleum equal weight) at 165—185°C for several hours. The resulting product is condensed with formaldehyde (60 per cent to the weight of naphthalene) at a temp. of 85°C.

20. *Research Workers*—Dr. H. G. Garg and Dr. M. M. Bokadia, D. S. B. Government College, Naini Tal.

Research Project—Synthesis of β-substituted α bromo α'- formyl-aceto-phenones.

Paper published– Synthesis of-substituted-bromo formylacetophenones. (*J. Indian Chem. Soc.*, Vol. *34* no. 4, 1957)

Synthesis and characterisation of bromo-oxymethylene-β (chloro, bromo, methoxy and methyl acetophenones have been described. They have been obtained both from sodium and copper salts of their respective oxymethylene-ketones. The copper complex method has afforded, in general, better yields of purer products.

21. *Research Workers*—Dr. R. G. Garg, Dr. Y. Singh and Dr. M. M. Bokadia, D. S. B. Government College, Naini Tal.

Research Project—Bromination of oxymethylene ketones through their copper salts.

Paper published– A note on bromination of oxymethylene ketones through their copper salts. (J. Indian. Chem. Soc, 33, 5, 1956.)

Wislicenus and Ruthing (Annalen, 1912, 389, 260) brominated oxymethylene desoxy-benzoin in glacial acetic acid. Deshpande *et. al* (J. Indian Chem. Soc. 1946, 23, 43; 1949, 26, 55) effected the bromination of oxymethylene-cyclohexanone and oxymethylene-methylethyl ketone in the same way. Bruhl Ber., 1904, 37, 2175, 2176) obtained bromo-oxymethylene menthone and brome-oxymethylene-camphor by adding bromine to the oxymethylene ketones, neutralised with caustic soda. Deshapande *et. al* (loc. cit.) obtained bromo-oxymethylene-acetophenone by the bromination of the sodium compound of oxymethylene-acetophenone in dry carbon tetrachloride.

We brominated oxymethylene-methyl-n-amyl ketone, oxymethylene-acetophenone and oxymethylene-camphor through their copper chelate compounds in an inert solvent. This method provides a better yield of the purer product, and the copper salt can be preserved easily. The copper salt method has been used in the preparation of α γ-dibromoethyl acetoacetate from γ-bromoethyl acetoacetate. Although bromination of oxemethylene-methyl-n-amyl ketone has also been effected in ethereal solution, the copper salt method is found to yield better results.

22. *Research Workers*—Dr. A. K. Dey and Sri Krishna Chandra Mathur, Department of Chemistry, University of Allahabad.

Research Project—Studies in anionic co-ordination compounds, involving carboxylic acid group liganas.

Paper published—K. C. Mathur and A. K. Dey ; On the composition of silver citrate, J. Ind. Chem. Soc., 34, 713 (1957).

The composition of lead and silver citrates precipitated by the interaction of the soluble salts with sodium citrate have been studied. The nature of the precipitate obtained by treatment of soluble argento-citrate by alkali has been investigated and found to be Ag_3 Cit.

Solubility experiments on the investigation of composition of lead and silver citrate complex are in progress.

23. *Research Workers*—Miss. Rajni K. Pandya and Kanti Lal Pandya, Chemistry Department, St. John's College, Agra.

Research Project—The condensation of aldehydes with keto-esters.

Papers published—The condensation of aldehydes with keto-esters. Part III. 3-hydroxy, 4-hydroxy and 3 : 4-dihydroxy-benzaldehydes, (J. Indian Chem. Soc., Vol. 34, No. 3, 1957.)

3-Hydroxy-, 4-hydroxy- and 3 : 4-dihydroxy benzaldehydes have been condensed with ethyl acetoacetate and ethyl benzoylacetate in the presence of piperidine and pyridine. The resulting mono and *bis-esters* have been characterised.

24. *Research Workers*—Dr. R. C. Mehrotra and Dr. K. C. Pande, Chemistry Department, University of Lucknow.

Research Project—Soaps of aluminium and titanium.

Papers published—

(i) Studies in aluminium soaps—I *J. Inorg. Nucl. Chem.* 2, 60 (1956)

(ii) Above II *J. Inorg. Nucl. Chem.* 4, 128 (1957).

(iii) Aluminium acetate, propionate and butyrate—*Z. anorg. Chem.* 286, 29 (1956).

(iv) Titanium cetate *Chem. and Ind* 114 1957).

(v) Titanium salts of mono carboxylic acids—I. *Z. Anorg. Chem.* 290, 87 (1957).

(vi) Above—II, *ibid.* 290, 95 (1957).

vii) Above—III, *ibid.* 291, 97 (1957).

The soaps of aluminium have received considerable attention for the last three decades, but the general volume of evidence seems to indicate the probable nonexistence of definite molecular entities. In this scheme has been described the synthesis of mono—, di— and tri— soaps of aluminium by simple metathetic reactions between aluminium alkoxides and different amounts of various fatty acids, removing the alcohol produced azeotropically with benzene. Heat treatment under reduced pressure, and solvent extraction with dioxane and acetone has been employed to establise the existence for tri—soaps for the first time beyond doubt. From the reaction of mono—and di—alkoxy aluminium soaps with acetyl chloride the corresponding chloride-soaps have also been prepared in a pure state.

The work has been extended to lower fatty acids as in their cases also alumi ium salts were not known with definiteness.

Extending the work to titanium, interesting features have been observed. Derivatives of titanium up to di-alkoxy di-acylates have been prepared by reactions similar those for aluminium. Further replacement with the formation of tri-acylate derivatives brings about instability and said reactions and, therefore, the tri-and tetra-acylate derivatives could not be prepared by these reactions Investigations have been carried out on the nature and mechanism of these decomposition reaction. Studies with the lowest member of the series also gave similar results. It has been found that the treatment of titanium tetra-derivatives ($TiCl_4$ or $Ti(OR)_4$) with acetic acid and acetic anhydride mixture resulted finally in a basic tri-acetate,

$$O < \begin{matrix} Ti(OAc)_2 \\ Ti(OAc)_2 \end{matrix}$$

which is also the end product, when hydrated titanium dioxide was treated with acetic anhydride.

The Research Assistant Sri K. C. Pande received Ph. D. degree on this work.

FORESTRY, BOTANY, AGRICULTURE, DAIRY AND PLANT PATHOLOGY

1. *Research Workers*—Dr. A. Purushotham and Sri P. N. Grover, Forest Research Institute, Dehra Dun.

Research Project—Preservative treatment of green bamboos.

The workers undertook the study of impregnation of green bamboos of the following species (1 *Dendrocalamus* 2) *Dendrocalamus longispathus* (3) *Bambusa polymorpha* using the following types of chemicals: (*a*) boliden salts, (*b*) ascu, (*c*) chromate zinc chloride, (*d*) zinc chloride, (*e*) borax-boric acid, santobrits. Side by side with the above experiments he studied the variation in the pH and surface tension of the dropping liquids. These data have given valuable information and it is proposed to collect data for more species of bamboos. These experiments were conducted in our local bamboo forest on a semi-commercial basis.

Dyeing of bamboos—While impregnation of bamboos in the dry or in the green state can be effected with water-soluble inorganic chemicals, serious difficulties are encountered with when water-soluble organic dyes are used. The dyeing of bamboos with different colours is very much sought for by the industry dealing with manufacture of artistic articles. Surface tension of the impregnating liquid is considered as one of the main factors concerning penetration of liquids through capillaries. Therefore, the effect of wetting reagents on the surface tension of water-soluble dyes has been taken up and data collected. Preliminary experiments confirm that with the reduction in surface tension, penetration improves. It is now intended to carry out systematic work on this aspect using different wetting agent and different dye-stuffs.

Standardization of polarograph for analysis of copper—Copper is one of the main constituents of some of the important preservative-compositions. To estimate copper in the treating solution as well as in the treated timber some difficulties are encountered specially when the quantity of copper present is small. By the polarographic method not only very minute quantity of copper can be estimated but also in the presence of other ions. Therefore, work was taken up for the standardisation of estimation of copper using the polarograph.

2. *Research Workers*—Sri C. R. Ranganathan, Forest Research Institute, Dehra Dun.

Research Project—Deterioration of timber by marine boring organisms at Bombay, Cochin; Travancore, Madras and Visakapatanam.

The investigations on the deterioration of timber by marine boring organisms are carried out at Bombay, Cochin, Travancore, Madras and Visakapatanam harbours.

Prior to starting research, all the senior research scholars have been given preliminary training at the F.R.I., Dehra Dun for a period of 3 months on various methods of timber preservation. The

nature of the investigation is to study the systematics, life histories and bionomics of organisms concerned with boring and fouling activities, different types of timber used for sea water structures in various localities, the hydrographical conditions of the sea water, the distribution and the physico chemical factors controlling the destruction of timber by these organisms and the evaluation of durability of treated and untreated timbers in sea water.

1. The timber used in various regions are for piles, jetties, fishing stakes, catamarans, fishing boats and country crafts. Teak (*Tectona grandis*, madat (*Terminalia tomentosa*) and mango (*Mangifera indica*) are used in Bombay. In the timber pond and Kali river large beams of teak, madat and many other species were severly damaged by the attack of marine borers, the chief of them being *Sphaeroma* and *Teredo* Spp. *Sphaeroma* bores ½" to 1" into the wood. *Teredo* grows to a size of 1' to 3½' in certain places. *Bombax* Spp, cocoanut (*Cocos nucifera*) and mango are used in Cochin and Travancore, red cedar (*Cedrela Spp.*) maruthu (*Aegle marmelos*) mango, teak (*Thespesia* Spp.) (*Lestoha Spp.*) and *Polyalthia* Spp., in Madras; and maddi (*T arjuna*) sal, *Shorea robusta*) bijasal (*Pterocarpous marsupium*) nalla maddi (T. tomentosa), gurjan, (Dipterocarpus Spp.), Burma teak, pine wood (*Pinus* Spp.) and pinkado (*Xylia dolabriformis* in Visakapatnam All these are subjected to the action of the marine boring organisms.

2. A survey into the systematics of marine borers was made by the research workers at all the centres mentioned above Molluscs and Crustaceans are found to be the chief organisms, but their intensity varies in various harbours and surrounding localities. In Bombay the molluscs *Martesia striata*, *Teredo navalis*, *T. sustinii*, *T. pertigens*, *Bankia destenhami*, and the *crustacean Sphaeroma* are the main borers. In Travancore and Cochin *Martesia striata*, *Bankia gouldi B. Setacea*, *B. exocalpa*, *phaeroam walkeri*, *Melita zeylanica*, are the main borers. Boring activities in *Mertesia sphaeroma* and Polychaetes were tested by precipitating dellulose from gut contents by treating with Schwietzer's reagent and acidifying with acetic acid. Only in *Martesia* and *Sphaeroma* a precipitate was found. Feeding tests on *Melita* showed that it has wood rasping properties. (This appears to be the first time that an observation of its wood rasping activities is made.) Piles taken from Cochin harbour and sectioned show that Teredo and *Martesia* attack begins from 3½" from mud line, reaches the maximum at 21" and slowly decreases, finally stopping at 40". In *Sphaeroma* the activity begins above 40" from mud line. In Madras the main borers are the molluscs *Martesia striata*, *M. fluminalis*, *Teredo manarasensis*, *T. clava*, *T. rehderi*. *Bankia*, *bengalensis* and Crustaceans *spheroom walker*, *Cirocana pleonastica*, *Stenothoe Gallensis*, *Elasmopus pectnicrus* and *Corophium Madrasensis*. The greatest damage is done by *Martesia striata* This can tolerate high salinity of the sea and low salinities of the brackish waters and estuaries. *Sphaeroma vastator* is also found to tolerate low salinity even up to fresh water if the salinity is lowered gradually. In Visakapatanam borers recorded are the molluscs *Teredo navalis*, *T. thomsoni*, *T. mannii*, *T. trulliformis*, *Bankia setacea*, *Martesia striata*, *M. multistriata*, *M. rovicola*, *M. americana* and Crustaceans *Limnoria* and *Sphaeroma*. Among crustaceans *Limnoria* has a very

wide occurrence. Apart from these, *Teredo disegensis*, *T. samoaensis* *T. parksi*, *T. bartschi*, *T. fucillatus*, *T triangulare* and *Bankia exoc lpa* are also found. Another molluscan borer *Bactronophorus thoracitus* is found attacking catamarans. Limnoria also attacks catamarans. Sphaeroma is found attacking timber of jetty piles. Gonad tests show ripe species throughout the year. *Teredo*, *Bankia* and Limnoria show wooden pieces in their stomach contents. But *Martesia* shows only *Phyto*—and *Zooplanktons*.

3. Studies on marine fouling organisms are also made. The main fouling organisms are Hydrozoans, Acorn barnacles, hydroids, tubiculus annelid worms; bryozoans, sea-anemonies, amphipods, neries, serpulid worms and bivalve molluscs.

4. Fungus and bacteria are also found to be aiding in the boring activities. In Cochin sectioned timbers showed fungal mycelia, spores and bacteria. Fungi penetrate cellulose walls and cause decay by hydrolysis of cellulose and cell contents. Attack by borers starts only after a few months of immersion. It is supposed that wood callulose and lignin decomposed by bacteria and fungi help to condition the initial attack.

5. Studies on physical and chemical stimuli on the activities of organisms were studied. The salinity of Cochin harbour shows great fluctuations due to the onrush of fresh water from the important rivers of the State. The average annual rainfall is 115 inches. The periodical changes in salinity has an influence in determining the intensity of attack of boring organisms. *Sphaeroma* and amphipods are capable of withstanding wide variations in salinity, but *Teredo* and *Bankia* are unable to do so. The latter survive only if the salinity is above 9000 ppm. *Melita zeylanica* survive only in brackish and fresh water.

In Madras experiments on the settlement of barnacels were done in relation to primary film formation, illumination, water currents, colour of the substratum and also the effects of poisons on naupliar and post-naupliar stages. In the experiments on primary film it is found that an initial film is a prerequisite for settlement, and that settlement takes place only after 48 hours which period is required for the formation of the primary film. Settlement is very quick if plates with a primary film are supplied. It is found that primary film cannot be accelerated by supplying algae, diatoms etc. which go to prove that fouling is a biological process depending on growth and multiplication of algae and diatoms in situ. Among the three components, algae, diatoms and bacteria, the latter is not found to play as decisive a roll as the former ones in aiding settlement of larvae. It may be that the algae entangle the fine setae of the larvae, and also serve as food for nauplii and also larvae of Polychaetes.

In illumination tests cyprids are found to settle during day time than in night though direct sunlight is not favourable *Balanus amphitrite variegatus* prefers an intensity of 5 foot candles, and *Balanus tintinabulum tintinabulum* 0·5 foot candles; whereas *Othalms* requires 35 foot candles.

Experiments with rotating disc showed that *B. a. variegatus* do not settle at a speed of 652 r.p.m. (1·76 knots) while at reduced speeds they are able to settle and at 40 r. p m. 1·08 knots) many are able to settle. Hence beyond 1·08 knots settlement is not possible.

In testing preference to colour glass plates of various colours were supplied. Red, black and white attracted maximum numbers while blue, green and grey the least.

Toxicity tests show that mercury is more poisionous than copper in all naupliar stages, even though older ones can tolerate the same amount than younger ones. Small concentrations as 0 08 to 0·1 mg. of Cu/1 and 0 03 to 0 04 mgm. of Hg/1 are sufficient to prevent settlement of cyprids of *B.a variegatus*. For cyprids of *B t. tintinabulum* 0 01 to 0·2 mg of Cu/1 and 0·005 to 0·01 mg of Hg/1 can prevent settlement while 0·07 to 0 09 mg. of Cu/1 and 0 03 to 0·04 of Hg/1 can prevent settlement of cyprids of *O. s. stellatus*.

In Visakapatanam the conditions of two stations were studied and it was found that the two stations had wide variations in chemical constituents, as given below :

Station	Duration of experiment	Tempr. range	Salinity range	O_2 range
1	April to December.	28 8—29·3°C	19‰—33·8‰	2 ml/L to 4 ml/L.
2	Ditto ...	26·9—29·9°C	6·1‰—32·7‰	Trace —2 ml/L.

Vertical distribution was tested by fixing test sal poles 5′×3″×3″. Observations were made from September to December. Fouling organisms were noted, but no borers during this time. The poles were found to be sound. Similar tests are being conducted with Deodar *Cedrus deodara*) and Nallamaddi (*Terminalia tomentosa*).

Laboratory tests on *Martesia* and *Limnoria* were conducted to study the effect of low salinity and O_2 t take. *M. striata* is normally active in a salinity of 9-12 parts per 1000. Below 9 and 5 parts per 1000 functional individuals decrease and at 4 parts per 1000 all die. Lethal salinity is fixed at 5 to 7 parts per 1000-O_2 intake of adult *Martesia* is about 0 56 c.c. per 1000 per hour. Limnoria can tolerate 6 parts per 1000 below which all die. O_2 intake per hour is ·0722 5 ml/L.

Adult *Martesia* are very active under illumination (100 watts bulb) than in normal light.

3. *Research Workers*—Dr. Bimal Kumar Bakshi and Sri K. K. Arora, Forest Research Institute, Dehra Dun.

Research Project—Wilt and other root diseases of *Shisham* (*Dalbergia Sissoo* Roxb). Biochemical and physiological studies of the pathogens with a view to evolve control measures.

1. *pH and soil texture and incidence of wilt*—Soils were collected from widely separated localities like Dehra Dun, Saharanpur, Ramnagar, Haldwani and Tarai and Bhabar forest divisions both from natural forests and plantations. pH of the soils were determined by glass electrode Textures of soils were determined by 'mechanical analysis' following Robinsons' method (Wright, C. H., 1934—Soil Analysis, a Handbook of Physical and Chemical Methods). Two samples, one at 6 inches, other at 3 feet depth, were taken for each soil and a total of 14 soils (with 28 soil samples) from the above localities was analysed. Sampling at the two depths, 6 inches and 3 feet, was done because most of the lateral roots of *shisham* lie at this region. pH values of the above soils indicated that there was no correlation between pH and incidence of wilt. Mechanical analysis of the soil samples, however, yielded a significant result. It was observed that in areas, both natural forests and plantations, where wilt is absent, the soil contains a high proportion of sand (55—90 per cent), both coarse and fine, and a low proportion of silt and clay (usually 10—20 per cent rarely more.) Such soils are variously classed as coarse sand, sandy loams, fine sandy loams and very fine sand (classification after U. S. bureaux). In areas with high incidence of wilt, on the other hand, the proportion of sand (coarse and fine) is low (30—40 per cent) while that of silt and clay high (over 60 per cent). Such soils are termed clay loam. Between these two extremes, there are soils where the disease incidence is sporadic (soils loam or clay loam) or moderate (soils sandy clays).

These results suggest that *shisham* grows well free from diseases in loose, sandy soils as in riverain beds while in stiff, clayey soils, the trees suffer from wilt. In plantation work, therefore, *shisham* should not be raised in areas where the proportion of silt and clay in the soils is high.

2. Though pH values of soils did not indicate any correlation between pH and disease incidence, studies on the growth of *Fusarium solani*, the wilt fungus, was made on artificial medium (Richard's liquid medium) adjusted to different pH varying from 2, 5 to 8, the difference between any two pH being about 0·5. It was found that the fungus grows best at about pH 5, above and below which the fungus growth declines. Another significant feature was the formation of a pink pigment at pH 5. It may be mentioned that *Fusarium solani* causes a pink stain in the wood. The formation of pigment by *Fusarium solani* will be studied together with the pH determinations of both healthy and diseased roots to see whether any significant results can be observed. Other aspects on this line of approach include change in pH of a medium with age of cultures, and grand period of growth of the pathogen at optimum pH and temperature.

3. Two theories are advanced to explain the mechanism of wilt; (1) plugging theory where the pathogen is supposed to clogg the vessels so that there is a physical blocking of transpiration current resulting in wilting and (2) toxin theory, where the wilt is due to some toxin developed by the pathogen.

To prove this, the pathogen was grown in liquid culture for a certain period after which the liquid was filtered through a sintered glass funnel so that the filtrate was free from any spore. Shisham seedlings grown on this fluid were wilted, while controls set up remained healthy. The techniques of these experiments are being modified and results will be reported later.

Shisham (*Dalbergia sissoo* Roxb.) an important timber species in the plains of Northern India, grows naturally along riverain beds and also raised artificially in plantations. In its natural habitat, shisham grows healthy but in certain plantations, the tree suffers from root diseases due to *Fusarium solani* which causes wilt. *Ganoderma lucidum* and *Polyporus gilvus* which cause root rot. All the three fungi are soil organisms. With respect of *Fusarium solani*, it has been proved that the fungus is an ubiquitous soil saprophyte capable of intense saprophytic colonisation and belongs to the 'soil inhabitant' class. The fungus occurs in all soils both in riverain beds and plantations but the trees are free from any disease in the former but suffers from wilt in the latter areas. An attempt was therefore, made to find out the susceptibility of shisham to wilt in some plantations by correlating soil characters like pH and soil texture with the health of plants. In addition, biochemical studies *Fusarium solani* and the mechanism of wilt were also studied.

4. *Research Workers*—Sri S. K. Seth and Sri H. P. Bhatnagar, Forest Research Institute, Dehra Dun.

Research Project—Physiological and ecological relations of *Shorea robusta* with other forest tree species occurring in different types of habitats of U. P.

The workers have carried out the macro-element analysis of sal soils from different depths for about 50 samples collected in the tour of sal forests of Uttar Pradesh. The samples were analysed for the following elements : nitrogen, calcium, magnesium, potassium, phosphorus and organic matter.

Their pH were also determined. The workers collected sal leaves in their tour of sal forest areas. Its leaves were also examined for nitrogen, calcium and magnesium. The workers further chemically analysed the needs of about 9 species of such common trees as may be called associates of sal. They have also carried out Pot Culture experiments in order to find out the requirements of different elements and to know the cause of dying back of sal seedlings and have made detailed studies of nutritional balances in such cases. They have further carried out in details experiments to the soils collected from various places, for example, Kishanpur Range of South Kheri Forest Division, from Dudwa Range of North Kheri Forest Division, from Haldwani and Ram Nagar Forest Divisions, from Motipur Range of Bahraich Forest Division and from Dehra Dun Forest Division. The sal leaves for analysis were

collected from Motichur Range, Lachhiwala Range, Malhan Range, Barket Range, Thano Range, and Timli Range. Soil samples were taken from different depths ranging from zero inch to eighteen inches. The authors also made ecological study of the vegetation of the sal product forests.

5 *Research Workers*—Dr. S. B. Singh and Dr. G. D. Agrawal Government Agriculture, College, Kanpur, U. P.

Research Project—Evaluation and demonstration of the economic benefits of improved technical and technological practices on farmers' holdings for the year 1954—1956.

In India there has been lack of agricultural economic research on problem concerning farm management, production economics and resource productivity on an organised and regular basis. Few investigations that have been conducted in the country during the last three decades had been to find out the cost of production of major crops. So far little efforts were made to study holding as a whole on farmers' condition for evaluating benefits of improved technique of farming. At the instance of the U. P. Government Scientific Research Committee this scheme was sanctioned under the guidance of Dr. G. D. Agrawal, Agricultural Economist, Government Agricultural College, Kanpur to find out the possible increase in the production and net return from improved farming under farmers condition through farm planning.

This scheme was started since July 9, 1954 when Research Assistant joined but preliminary selection of villages and holdings had been completed well in advance with the help of District Agriculture staff. The investigation was conducted on 24 cultivators' holdings in two villages, Rarha and Halpura in district Kanpur. The villages are situated at a distance of 29 and 41 miles, respectively from Kanpur City. They were selected at a long distance from city to eliminate the influence of the city conditions and thereby to ensure typical farming conditions as prevalent in rural areas. The data pertains to two agricultural years 1954 to 1956. Both the villages have fertile alluvial soils. Nearly the entire cultivated area of village Halpura is irrigated with wells. In 1955-56, i.e. in the second year of the study, the well irrigation in this village was largely replaced by a tube-well. In Rarha all the cultivated area is irrigated with canal. Both villages are inhabited by *Kurmis*, a caste well known for its farming skill. The major crops of the villages are maize, wheat, jwar, arhar and potato. In Halpura in addition to these crops tobacco and melon is also grown extensively.

Objects—(i)To explore the possibilities of budgeting approach to farm planning in India.

(ii) To evaluate and measure the economic and other benefits accruing to the farmer by the adoption of the improved agricultural practices the recommendations regarding the improved practices were rawn up on a co-ordinated basis for the farm as a unit.

(iii) To find out the suitability of the recommendations for the average farmer in terms of his resources, i.e., land, labour, equipment, marketing facility and his needs for foodgrains and cattle feed.

(iv) To determine precisely the direction and extent of additional state and cooperative assistance needed by the farmer to enable him to adopt the recommended practices.

(v) As an ancillary to the above, data concerning farm assets, farming costs and returns, etc, also became available for 24 cultivators' holdings for two agricultural years, 1954—56.

Technical programme—The agricultural holdings of each village were surveyed to find out their distribution in various size-groups Twelve farms from the most representative size-group were selected in each village. Six of these were selected purposely from amongst the farmers who were willing to adopt the recommended practices. The remaining farmers were selected randomly. Beginning with agricultural year namely, June 1, 1954, detailed physical data and cost records were maintained for each selected holding on day-to-day basis by the cost accounting method. Printed schedules were used for the purpose.

No farm planning was done in the case of randomly selected farmers. The object of maintaining farm accounts in their case was to get information concerning production, cost and return, etc. on holdings under the village system of farming. Alternative farm plans were prepared for the remaining six farms in consultation with the departmental technical experts and after free discussion with the farmers concerned. The practicability of the alternative farm plan was the major guiding consideration in preparing the alternative farm plans. The average size of sample holdings following and those not following the alternative farm plan was 8·79 acres, respectively.

Although it was known that the farmers could increase their earnings by growing sugarcane, yet since the facility for marketing sugarcane to sugar mills was not available and the farmers were not familiar with the technique of *gur* making, sugarcane was not included in the cropping scheme prepared under the alternative farm plan. Sugarcane was also liable to damage by blue bulls and jackals. Similarly, the cultivation of maize was known to be uneconomic but it was not recommended to drop its cultivation because the farmer needed it for his own consumption and for his cattle and also, according to the local custom, for payment of wages to the labourers. Maize was retained in the cropping scheme also because there was no other alternative crop which fitted so well in the rotational arrangements. Detailed schedules of all the cultural operations had been prepared separately for all the twelve selected farms following planned farming, i.e. number of ploughings, irrigation, quantity of improved seeds and manure and time of other cultural operations, etc.

The additional requirements of improved seeds, fertilizers and implements for the adoption of the alternative plan was assessed well in advance. The District Agricultural Officer made available such assistance tothe extent he could do that within his budget resources. No.

other special arrangements for such assistance could be materialised. The Research Assistant, who was a graduate in Agriculture with post-graduate training in agricultural economics stayed in the villages at the time of important agricultural operations and helped the farmers in the adoption of recommended improved agricultural practices by actually demonstrating the improved methods on the cultivators' farms. The Agricultural Economist, incharge of the project, also paid visits to supervise the filling of the schedules and mainly to ensure better co-operation of the farmers with the project programmes and to remove difficulties faced in the execution of the project. In preparing the alternative farm plan the emphasis in the main was placed on the adoption of the following improved practices:

(1) Use of high yielding and improved varieties of seed.

(2) Timeliness of cultural operations.

(3) Green manuring.

(4) Turning in of green manure with soil turning ploughs.

(5) Use of fertilizers.

(6) Interculture in wheat with hand hoe.

(7) Use of 'Olpad' thresher in threshing *Rabi* crops.

A pre-operational survey of the cropping programme followed by by the farmers before the introduction of the project in the villages showed that the crops grown by them were quite suited to their farming conditions, resources and needs and it was not thought necessary to make any drastic change in it. However, the practice of keeping the land fallow during the rainy season was discouraged and the farmers following the alternative plan grew green manure crops in these fields. An examination of their manurial resources revealed that after the application of available farmyard manure to the maize and potato crops little manure was left with them for use in wheat. They were also not in a position to purchase manures for their wheat crop. Green manuring, therefore, suited them very well as it did not require much additional expense and at the same time met fully the requirement of nitrogen for wheat.

The budgets for the sample farms were prepared for 1954-55 on the basis of the farming practices followed by the selected farmers before the adoption of the alternative farm plans. The information required in preparing these budgets, i.e., yield of crops, quantities of seed, manure, human and bullock labour, etc. was enquired from the farmers. The valuation of these items was done according to their prices current in 1954-55. In these estimates, the yields taken into account were higher than the average, i.e, these yields which the farmers got in a good agricultural year. No such budgets were prepared for the sample farms not following the alternative farm plan. The comparative data of the farms concerning income, expenses, etc. as in the budget estimates before farm planning and those actually obtained after the implementation of farm plan and also those of the sample farms not following farm plans are given below:

TABLE 1—*Gross income, etc. on the farmers holdings before and after the adoption of farm plan.*

Value in rupees

Measures	Budget estimates before farm planning	Budget estimates based on the alternative farm plan	Actual results obtained after farm planning			
			1954-55		1955-56	
			Value	Percent difference	Value	Percent difference
Gross income	2084	2867	2587	24·1	2717	30·3
Total cultivation expenses...	1237	1682	1497	21·2	1547	25·1
Net return	847	1285	1090	8·7	1170	38·2
Return to capital, family labour and management.	1213	1586	1415	16·7	1498	23·5
Interest on investment—						
(*a*) Land at 3 per cent	217	217	217	...	217	...
(*b*) Draught, cattle and implement at 5 per cent.	28	42	32	...	37	...
Return to family labour and management.	968	1337	1166	20·5	1244	27·9
Gross return per M. W. D.	3·2	3·81	3·6	13·0	3·7	16·0
Net return per M. W. D. *	2·1	2·57	2·4	14·3	2·45	17·0

* M. W. D. represents Man Working Day.

TABLE 2—*Comparison of gross income, etc. of the farms (A) not following and (B) following alternative farm plan.*

Value in rupees

Measures	1954-55			1955-56		
	A	B	Difference in percent	A	B	Difference in percent
Gross income	2096	2587	23·0	2112	2717	29·0
Total cultivation expenses...	1221	1497	21·5	1241	1547	24·6
Net return	875	1090	24·5	871	1170	34·3
Return to capital, family labour and management.	1187	1415	19·2	1192	1498	25·9
Interest on investment—						
(i) Land at 3 per cent	234	217	..	234	217	...
(ii) Draught, cattle and implement 5 per cent.	28	32	...	24	37	...
Return to family labour and management.	925	1166	26·0	936	1244	32·9
Gross return per M. W. D.	3·2	3·6	13·0	3·2	3·7	16·0
Net return per M.W. D. ...	2·1	2·4	14·3	2·15	2·45	15·2

There was increase in the value of gross produce and net returns in all the 12 cases in both the years. The percentage increase in the value of gross produce, net return and return to capital investment, family labour and management show an increase of 24 to 30, 29 to 38 and 17 to 24 per cent, respectively. However, the income received falls short by about 19 per cent when compared with the estimated income, from the alternative plan, based on the recommended practices. In no case the income received is equal to that estimated. The major causes responsible for the lower income are (1) the slightly lower prices actually received as compared with the estimated value of the farm produce, and (ii) the lower yield of potato than the estimated yield as it was not possible to procure enough quantity of potato seed of the variety which had been recommended originally for sowing and which was a high yielding one.

The values of gross income, total expenses, net returns and other measures of profit for each individual holding before planning and those actually realized in 1954-55 and 1955-56 after the adoption of the planned programmes of farming are given in Appendices I, II and III. The terms used for various measures of farm profit are explained in Appendix IV. The range for increases in gross income and other values in percentage form are shown below:

Particulars	Range of variation in 1954-55	Percentage 1955-56
Gross receipt	17 to 36	20 to 43
Cost of cultivation ...	8 to 36	16 to 37
Net return	12 to 52	27 to 74
Return to capital, family labour and management	10 to 35	12 to 42

The highest values of different measures of farm profit have been realized in case no. 6 in both the years. This farmer was able to implement nearly fully the recommendations made under the alternative plan for his holding. He applied the recommended dozes of manure to potato and wheat crops. He won the first prize in the wheat crop competition for the district in the first year of the project and the first prize for the district in potato crop competition in the second year of the project. The percent increase in net return exceed 30 per cent in 4 cases in first year and in 5 cases in the second year.

The comparative yields of the principal crops in maunds per acre on the sample farms are given below:

Crops	Yield on farms before ploughing	Yields in maunds per acre	
		1954-55	1955-56
Potato	99·0	128·5	134·7
Wheat	10·5	12·6	13·1
Maize	7·6	9·2	9·5

It will be seen that the average increase in yields after planning is not at all high. The highest yield obtained by the selected farmers following planned farming are given below :

Crops	Years	
	1954-55	1955-56
Potato	307·6	298·5
Wheat	27·3	25·9
Maize	16·5	15·5

Even these yields are less than the highest yields in the area as indicated in the crop competitions. Therefore, it is possible to have still larger increase in the total return if the farm plan is based on more adequate resources. In this project, the planning was done on a modest basis as explained later.

The prices taken into consideration in preparing the budget estimates of income and various other returns and these actually realized in 1954-55 and 1955-56 are given below :

Commodities	Prices per maund in rupees		
	Used in preparing alternative budget	1954-55	1955-56
Potato	4·5	4·3	4·5
Wheat	15·0	13·5	14·5
Maize	10·5	9·0	10·0

The prices actually realized in 1954-55 were slightly lower than those taken into consideration in preparing the alternative budget for the farmers following the improved plan. The farmer realized better prices in 1955-56 as compared with 1954-55. Both better prices and better yields account for higher values of gross income, etc. The weather conditions in both the years were nearly normal. The crop did not suffer any appreciable damage due to bad weather conditions or prevalence of insect pests and diseases. Only a small area under wheat was affected by rust in 1955-56 while there was some damage by rats in 1954-55.

The total cultivation expenses also increased to the extent of 21 per cent to 28 per cent. The increase in expenses is accounted for mainly by the following.

Percentage increase due to items	1954-55	1955-56
Cakes and fertilizers	54	56
Wages	24	23
Seed	19	20
Miscellaneous	3	1

Cakes and fertilizers' account for more than 50 per cent of the increase in the farming expenses Wage constitutes the next major item of increased expenses, however, it does not actually increase the expenses, for the additional labour is mostly the family labour and the increase in cost represents only its imputed values.

On an average the cultivation expenses increased by Rs.260 and Rs.300 and the gross income by Rs.503 and Rs.633 during the year 1954-55 and 1955-56 respectively. Thus for each additional rupee there has been an increase of Rs.2·0 and Rs.2·1 in the values of gross produce and Rs.1·70 and Rs.1·82 in the total return on capital investment, family labour and management respectively during the years of study, i. e. 1954-55 and 1955-56.

This project has demonstrated clearly the advantage of budgeting method in improving the yield and net return in farming. As an extension method it can be commended greatly. Firstly, because the farmer finds the farm programme prepared in this manner readily acceptable. The usual practice is to recover the farmer improved practices without any attempt at coordinating them. In this case the plan was prepared treating the farm as a unit and took fully into consideration the farmers' resources, marketing facility, technical ability, etc. The farmers find it difficult to synthetise the individual recommendations emanating from different sources. Secondly, this approach carries complete conviction to the farmer as he is able to know his gains and losses in rupees and paisas whereas generally the economic aspects are less emphasised by the scientists who usually confine their observations to quantitive increase in yields. Thirdly, farm planning as an ocular extension demonstration was found to have better effect not only on the farmers following the alternative plan but also on the rest of the farmers of these villages. The present method of half-plot demonstration being limited in area and to a few plots here and there is not

so effective in demonstrating the differences between the local and improved practices. Contrary to this, in the planning approach to farming there are fileds after fields showing distinctly different crop growth and giving better yields.

In the absence of adequate additional funds it was not possible for all the sample farmers to implement completely the recommendations made in the alternative plan. The district agricultural staff had been visiting the villages even before and as a result of their efforts the farmers in these villages had adopted to some extent the improved methods of farming and their average yields were higher than the average for the district. Both these facts strengthen further the confidence that in the case of more backward areas with poor farming methods the increase in the production and net returns through farm planning would be of a much higher order.

APPENDIX I

Existing values of gross income, etc. and other measures of farm efficiency on the holdings before planning

Measures	Average	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case10	Case11	Case12
Gross income	2084	803	841	1153	1178	1435	1815	1827	2165	2595	3490	3500	4207
Cost of cultivation ..	1237	435	465	718	796	946	1130	1141	1295	31588	2075	2018	2337
Net return	847	368	376	435	382	489	689	686	879	1007	1415	1482	1870
Return to capital family labour and management.	1213	529	603	695	643	764	1059	1008	1163	1532	1915	1932	2413
Interest on investment—													
A. Land at 3 per cent	217	102	133	120	947	143	168	196	231	303	328	345	414
B. Implements and draught at 5 per cent.	28	14	15	17	21	22	24	31	32	37	89	41	43
Return to family labour and management.	968	413	485	558	475	591	877	781	900	119	1558	1546	1956
Gross return per M. W. D...	3·2	3·7	3·2	3·6	3·2	3·4	3·7	2·9	3·1	2·7	2·8	2·9	3·1
Net return per M. W. D. ...	2·1	2.5	1·9	2·3	2·2	2·1	2·6	1·8	2·1	1·9	1·8	1·9	2·1

APPENDIX II

Actual values of gross income and other measures of farm efficiency on the holdings in 1954-55

Measures	Average	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Cose 9	Case10	Case11	Case12
Gross income	2587	1041	1035	1427	1434	1735	2417	2337	2568	3417	4081	4367	5156
Cost of cultivation ...	1497	556	612	808	925	1077	1405	1387	1398	2976	2475	2401	3037
Net return	1090	485	423	619	499	658	1042	958	1170	1441	1606	1966	2119
Return to capital family labour and management.	1415	711	732	795	868	961	1360	1312	1336	1782	2105	2 74	2665
Interest on investment—													
A. Land at 3 per cent	2 7	102	103	120	147	143	168	196	231	303	328	345	414
B. Implement and draught cattle at 5 per cent.	32	18	19	21	23	29	30	32	38	39	42	44	49
Return to family labour and management.	1166	591	610	654	698	789	1162	1088	1067	1420	1735	1885	2202
Gross return per M. W. D ..	3·6	3·9	4·2	4·0	4·0	4·7	6·2	3·2	3·4	3·1	3·2	3·1	3·3
Net return per M. W. D. ...	2·4	2·6	2·8	2·7	2·8	2·5	2·9	2·1	2·3	2·1	2·1	2·2	2·3

APPENDIX III

Actual values of gross income and other measures of farm efficiency on the holdings in 1955-56

Resources	Average	Case	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Crse 9	Case10	Case11	Case12
Gross income	2717	1161	1138	1387	1671	1823	2597	2468	2691	3287	4479	4623	5290
Cultivation expenses ...	1547	584	718	836	930	1072	1404	1418	1537	1897	2539	2678	3082
Net Return	1170	577	501	551	741	751	1193	1043	1154	1390	1931	1945	2254
Return to capital family labour and management.	1498	727	715	812	1005	1012	1474	1354	1553	1788	2427	2400	2709
Interest on investment—													
A. Land at 3 per cent	217	102	103	120	147	143	168	196	231	303	328	345	414
B. Draught Cattle and implement at 5 per cent.	37	18	23	21	29	24	41	41	54	48	49	53	48
Return to family labour and management.	1244	6·7	589	671	833	845	1265	1117	1273	1437	2050	2011	2247
Gross return per M. W. D..	3·7	4.0	3·9	4·1	4·0	3·7	4·2	3·2	3·4	3·1	3·1	3·1	3·4
Net return per M. W. D. ..	2·45	2·9	2.8	2·7	2·8	2·6	2·8	2·0	2·4	2·1	2·1	2·1	2·3

APPENDIX IV

Explanation of terms used

Gross income—

(i) Cash received for the produce (main as well as the bye-product).

(ii) Values of the produce used in the household or held over for the family.

(iii) Value of seed kept for sowing.

(iv) Value of the produce given over as wages or customary charges.

Cultivation expenses—

(i) Wages of hired labour paid in cash or kind.

(ii) Imputed value of family labour.

(iii) Value of seed, manure (purchased) and other cash expenditure.

(iv) Rent of land.

(v) Depreciation on live-stock and implements.

(vi) Interest on land, draught cattle and implements.

(vii) Other miscellaneous costs incurred in marketting, etc.

Net income—

Difference between gross income and cultivation expenses.

Return to capital, family labour and management—

Comprises net income, imputed wages of family labour and interest on owned capital.

Return to family labour and management —

Includes net income and imputed wages of family labour.

Gross return per man working day—

Has been obtained by dividing the value of gross produce by the total man days utilized on the farm in the agricultural year. Female and child labour have been converted into man equivalents.

Net return per man working day—

Has been obtained by dividing net income and wages of family and hired labour by the total man days in the year.

6. *Research Workers*—Dr. B. N. P. Ghildayal and Sri K. S. Awasthi, Government Agricultural College, Kanpur.

Research Project—Study of the nature of the process of nitrification in the alluvial soils of Uttar Pradesh.

(*a*) After an exposure of 100 days NH_3—N, and total N decreased in both the exposed and covered unsterile sets, NO_3—N, however, increased slightly more in exposed than in covered. Under sterile condition NH_3—T. N. content of the set increased considerably both under exposed and covered conditions, but NO_3, content only slightly. The increase in N-NH_3 and T. N. under sterile conditions seems to be due to the absorption on NH_3 as air soils from the atmosphere as postulated by Ingham (1950). The low pH in the sterile sets may also have helped in better ammonia absorption.

(*b*) Nitrification in soil after an exposure of 130 days NO_3—N has increased more in covered sets than exposed especially under unsterile conditions. The higher temperature and lesser heat losses in covered sets seem to help in better nitrification. Under unsterile conditions the NH_3—N nitrified better due to the activity of microflora. The losses of nitrogen seems to be due to an increased nitrification and decomposition of NH_4—NO_3 during nitrification (Dhar 1934). In unsterile sets under optimum conditions of temperature almost all the NH_3—N is converted to NO_3 and total nitrogen also increased. This shows the biological nature of nitrification.

The above results indicate that slight nitrification contains in the sterile sets also put the bulk of nitrate formation in the soil is due to biological activity.

7. *Research Workers*—Dr. J. C. Edward, Agricultural Institute, Allahabad.

Research Project—'Mastitis' in making herd of cows.

The following six tests were applied in connection with this work—

(i) Bromthymol blue test.

(ii) Chloride test.

(iii) Leucocyte count.

(iv) Plating of milk samples in Edward's esculin crystal violet blood agar

(v) Plating of milk samples in blood agar.

(vi) Hotis test with microscopic examination.

In all 67 milk cows were subjected twice to all the tests listed above. The tests 1 and 2 were found to be misleading and therefore, abandoned for the future work. The 3rd test was undertaken to find out correlation between leucocyte count and infection for this herd.

The results of the tests made along with the conclusions are furnished in the given table:

Breed	Number of animals tested	Number of animals diagnosed as positive	Percentage of animals diagnosed as positive
Sindhi ...	9	6	66%
Cross-breed	58	26	45%
Total ...	67	32	47·7%

The results show lower percentage of infection in crossbreed animals 45% than in pure Sindhi breed (60 per cent). This result cannot, however, be taken as conclusive because the number of pure Sindhi cows taken for comparison (9) with crossbreed animals (58) with respect to predisposition to mastitis is rather low.

Percentage of chloride in positive and negative (for mastitis)

Milk samples—3 from each

Cow number	Mastitis + or —	Percentage of chloride
48	+	0·2744
338	+	0·1349
848	+	0·2396
261	—	0·2699
225	—	0·2163
290	—	0·1199

Results clearly indicate an erratic relationship between mastitis positive milk samples and their chloride content.

Fluctuation in chloride per cent of milk samples collected in 4 consecutive days of 2 positive and 2 negative (for mastitis) cows :

Cow number	Mastitis + or —	Chloride per cent in different tests			
		1	2	3	4
48	+	0·2124	0·2301	0·2124	0·2301
		0·3009	0·1947	0·177	0·177
		0·2478	0·2301	0·2478	0·2301
		0·2124	0·2124	0·1593	0·1947
770	+	0·177	0·1593	0·1593	0·1416
		0·1062	0·1593	0·1593	0·1239
		0·1593	0·1593	0·1593	0·1239
		0·1416	0·1416	0·1593	0·1416
261	—	0·354	0·177	0·2478	0·3009
		0·2124	0·1593	0·177	0·2124
		0·3363	0·1593	0·2478	0·3186
		0·3717	0·1593	0·2655	0·3009
290	—	0·1239	0·1062	0·1239	0·1239
		0·1239	0·1416	0·1239	0·1239
		0·1239	0·1416	0·1239	0·1239
		0·1416	0·1593	0·1239	0.177

Results show wide variation in chloride content of milk samples taken at a time from the four quarters of one and the same cow. A similar variation is also observed in chloride contents of milk samples from a test on four consecutive days. These results conclusively show that chloride tests are not dependable in the diagnosis of mastitis.

At present, testing of milk samples is being done for the third time. The studies on correlation between leucocyte counts and infections is nearing completion. Cultural work on bacteria isolated from milk samples showing positive tests will be undertaken to establish their specific identity as soon as the chemicals are made available.

Segregation of the infected cows has already been done. A few patent antibiotics are being tried for their efficacy in controlling mastitis. The results of the trials will be furnished after completion.

8. *Research Workers*—Dr. J. C. Edward, Allahabad Agriculture Institute, Allahabad.

Research Project—Mastitis in the Institute herd.

That both subclinical and chronic mastitis are of common occurrence in dairy herds of India and countries outside is a recognized fact and the Allahabad Agricultural Institute herd is no exception to it. McClurkin (1951) with a view to control the incidence of mastitis in the Institute herd made efforts to isolate and identify the causal organisms. From his investigations he concluded that the high percentage of incidence of severe sporadic mastitis occurring in monsoon seasons was due to a species of *Pseudomonas* and that muddy condition prevailing during these seasons was one of the contributing factors to the increased incidence.

The present study was undertaken with the main object of diagnosing subclinical cases of mastitis by subjecting milk samples to bacteriological examinations and identifying the associated organisms so that methods of control may be adopted accordingly. To some extent study on comparative reliability of a few tests for diagnosis has also been done aside from testing the efficiency of a few proprietory drugs for control of the disease under uncontrolled conditions.

In all 132 milch cows (86% crossbreeds, mostly J×S) were tested for subclinical mastitis infection by chemical and bacteriological examination of the milk from individual quarters. The quarters were also subjected to physical tests. Of the 132 cows only 55 were tested four times during the period of investigation whereas the remaining from 1—3 times. The method of collecting milk samples was same as that described by Little and Plastridge (1946 except that the disinfectant used was Dettol.

The methods of diagnosis include physical, chemical and bacteriological. Attempts were made to carry on the diagnosis of infection also. The authors have reported their results on Digital Palpation Test, Bromothymol Blue Test, Chloride Test, Leucocyte count, and Hotis test. The weekly haemolytic streptococcal colonies were identified as Streptococcus agalactiae. In clinical as well as subclinical types of mastitis infection either *Streptococ* or *Staphylococci*, either individually or combined, were found associated. In the clinical as well as subclinical types of mastitis occurring in the Institute herd the pathogenic forms associated were *S. agalactiae*, *M. pyogepes* or both combined to the extent of 41%, 9%, and 50% respectively. The percentage of quarters shedding

the casual bacteria were highest (40) in rainy season and least in summer (29·2) and a little less than in rainy season during winter (37·1). The percentage of quarters shedding the causal bacteria within a lactation period was highest in the early (40·0) and late (40) and least in the middle (17·8) period of lactation. Of the 55 cows the quarters of which were tested 3—4 times during the period of investigation 24 (43·6% were found to shed the casual organisms regularly whereas the remaining 56·4 irregularly. The former category would be the carrier of the disease and therefore, need to be accordingly segregated and treated against the infection. The authors could not find any correlation between high yield and infection. The authors have tentatively suggested a few treatments for cows affected by mastitis infection. The medicines tried during the period of the infection were I. C. I's. Udolac, Bayer's Masticillin, M and B Protegan and Pfizer's Terramycin. The results indicate that Terramycin and Masticillin are equally effective in checking of the bacterial shedding and that Udolac is comparatively less effective. The authors hope that a prolonged treatment of the infected quarters with antibiotics might help in checking of shedding of bacteria.

9. *Research Workers*—Dr. V. Puri and Sri S. C. Sinha. School of Plant Morphology, Meerut College, Meerut.

Research Project—Monographic studies of *Acacia arabica*.

The research assistant has been able to prepare a large number of microtome slides and study them. He has made a special study of the nodal anatomy of the structure of the gland situated on anthers of *Acacia arabica*. He has made a critical analysis of some of his data.

10. *Research Workers*—Dr. R. N. Tandon, Sri K. S. Bilgrami and Sri R. S. Rawat, Botany Department, University of Allahabad.

Research Project—Leaf spot diseases of some garden and fruit trees.

(A) Since very little work has been done on the control of the leaf spot diseases in India and practically nothing has been done in Uttar Pradesh. Leaf spot diseases caused by *Phyllosticta* and *Pestalotia* have been reported practically from every country in this world. The authors have been able to isolate the following four organisms responsible for the leaf spot diseases of *Cycas revoluta*, *Artocarpus integrifolia* and *Mangifera indica* and *Nephelium litchi*.

1. *Phytlosticta cycadina*,
2. *Phyllosticta artocarpinae*.
3. *Pestalotia mangifera*.
4. *Pestalotia pauciseta*.

The work was divided into following two heads :

1. Physiological studies.
2. Pathological studies.

As the food supply greatly influences the growth and morphology of various organisms, it was decided to study the effect of various nutritional factors on fungi causing leaf spot diseases.

Though carbon, nitrogen, sulphur and phosphorous were found to be essential for the growth of both the species of *Phyllosticta* but most suitable sources of those elements have yet to be determined for each organisms, because they differ widely even in closely allied forms. Sucrose, starch and glucose were found to be good sources of carbon for *Phyllosticta cycadina* while glycerine, malic acid and tartaric acid were poor sources. Acetamide, various nitrates, glutamic acid and dl-valine were good sources of nitrogen, but ammonium compounds in general were not satisfactory for growth or sporulation. Most suitable pH. range for the growth of *P. cycadina* was between 4·8—5·2.

Raffinose and sucrose were found to be best carbon compounds while maltose and glucose were comparatively poor sources for the growth of *Pestalotia mangifera.*

Role of various amino acids on the growth and sporulation of *Pestalotia mangifera* was also studied. It was observed that dl-valine, leucine, tyrosine and glutamic acid were best sources while glycine was poorest source.

Pathological Studies—Pathogenicity of all the four organisms was established. Both the species of *Phyllosticta* developed disease even when the inoculations were made on the lower surface of the leaves without any injury.

Pestalotia mangifera was not able to cause infection without slight injury. Moisture was found to be very necessary for the development of the disease. Sections of infected leaves of *Cycas revoluta* revealed that except in the injured regions the mycelium generally entered through the stomata. *Pestalotia mangifera* was capable of infecting many varieties of mango fruits also.

(B) Three parasitic species of *Phyllosticta* viz., *P. carica papayas*, *P. mortoni*. and *P. morifolia* were isolated from infected leaves of *Carica papaya*, *Mangifera indica* and *Morus alba* respectively. The pathway of assimilation of six oligosaccharides by these organisms was studied chromatographically. Maltose and sucrose were assimilated through a hydrolytic pathway. Maltose was a better source than its hydrolytic product (glucose), while sucrose and a mixture of glucose and fructose were almost identical sources. Melibiose was hydrolysed by two species only viz., *P. carica papayae* and *P. mortoni*. Raffinose, lactose and cellobiose were unsuitable sources and they were used up through non-hydroloytic pathway. Hydrolytic products of these oligosaccharides supported very good growth of all the three fungi. The organisms synthesized an oligosaccharide (maltotriose) from maltose. *P. carica papayae* and *P. mortoni* were capable of synthesizing an oligosaccharide of unknown composition with melibiose also. Glucose and galactose were the best sources amongst the hexoses and the difference in their structural configuration did not play any important part.

The research assistant, Sri K. S. Bilgrami, working on this scheme has been awarded D. Phil. degree by the University of Allahabad.

11. *Research Workers*—Dr. G. S. Verma, Botany Department, Lucknow University, Lucknow.

Research Project—Virus diseases of plants top-necrosis of *Cyamopsis psoraloides* D. C.

Cyamopsis psoraloides D. C. (Guar) is widely cultivated in many parts of India and is used as a food and forage crop. This was found to be infected by a necrotic virus disease, hitherto undescribed from India. The infection was first observed during late July, 1956 in two fields far apart. The foliar symptoms were yellowing and stunting, rarely a light chlorotic mottling. Later, there was a general necrosis of the stem and growing point. By the beginning of September about 90% of the plants in the field showed definite symptoms.

Histopathology of the necrotic stem and leaves were also studied by cutting transverse sections of stem, petiole and the leaflets. It was found that the necrosis actually started superficially on the epidermal cells and later spread into the mesophyll region in the leaflets. Similarly in the petiole and stem the necrosis was limited to the epidermal and hypodermal cells. Such a condition in necrotic diseases is rather rare as almost all the necrotic virus diseases show the necrosis in vascular tissues particularly in phloem. But in this case the vascular tissues remain apparently normal.

Transmission experiments were carried out and it was found that the disease is sap transmissible. It was easily transmitted to Nicotiana *tabaccum* var. white burley, *Datura stramonium* and *Phacolus vulguris*.

Thermal inactivation and dilution end point of the virus were determined and were found to be $\pm$ 70°C. and 1 : 1,000 respectively.

The high percentage of diseased plants in the field suggests that probably the disease is seed-transmissible but a conclusion on this point needs further confirmation.

About 80% of the plants after reacting initially with an acutely necrotic disease later produced new leaves which were apparently healthy. Inoculation experiments from these "healthy" leaves positively confirmed the presence of virus, The sequence of an acute initial reaction followed by a later chronic stage is common to a number of virus diseases, especially those with symptoms of a systemic necrosis, but the recovery is rarely so complete as with "guar" virus.

A few plants in the field showed milder symptoms and inoculations from these plants proved that they were infected with an attenuated strain of the 'guar' virus. It was also observed that the presence of the attenuated strain in the plants confers against virulent strain.

The disease was first observed by K. Starr Chester (1944) in Oklahoma. There is no record of the disease from India.

12. *Research Workers*—Dr. G. S. Verma and Sri P. N. Saxena, Department of Botany, Lucknow, University.

Research Project—Studies on the effect of macro and micro nutrients on the multiplication of viruses with special reference to cruciferous plants.

The first aim to start with the problem was to standardize the technique which may be workable under the existing facilities and to evolve method to surmount such difficulties as commonly occur in the practical working out of a problem.

After careful consideration it was considered best to start with sand cultures where it would be possible to give such nutrition as the experimental conditions needed. Sand was obtained from Shankergarh near Allahabad. This quality of the sand was found to be the best but it needed chemical treatments to free it from all possible inorganic or organic components.

Treatment of the sand—The sand was first washed with ordinary tap water till all the salt and clay were removed. It was then subjected to the acid treatment. The sand was saturated with a mixture of 0·1% oxalic acid and 2·0% hydrochloric acid solution, Steam under pressure (2—2·5 Kg. per cm.^{2}) was then passed through it for three hours so that every sand particle could come in contact with the hot acid. Later, the sand was washed with tap water until the acidity was removed.

The second step was alkali treatment. The sand was saturated with 2% KOH solution and followed by steaming. Finally again the acid treatment was repeated. It was then washed with distilled water until its pH was constant at 7·0.

The sand so treated was found very suitable for the production of mineral deficiencies in the plants grown, since the treated sand was free from all the organic and inorganic components. The sand was then filled in glass containers which had a hole at the bottom and wrapped with thick brown paper so that no light could enter through the sides of the glass containers.

After the sand was fairly dry, still containing sufficient moisture for the germination of seeds, the pots were placed inside special cages lined by thin mesh (60 mesh to 1 square inch) so that insects could enter the enclosures.

Seeds of cabbage were sown 2—3, in each of the pots. When the seedlings were 2" in height the nutrient solution (Knop's) was given on alternate days. After the plants showed 3—4 leaves, one set was separated and was given nitrogen-deficient solution, the nitrate in the Knop's solution was replaced by sulphate. These plants showed symptoms of nitrogen deficiency. The other set was given normal solution.

Cabbage ringspot virus was then inoculated in both the sets by rubbing the leaves with extracted sap from diseased leaves. The virus infected plants were collected from suburbs of Lucknow where the disease was occurring.

When the virus became systemic in both the sets (after a month) the leaves from the 'normal sets' were collected crushed and the sap squeezed out. The crude sap was centrifuged three times and then filtered

through a bacteria-proof Sietz filter paper. This sterilised (free from bacteria) sap was inoculated intra-peritoneally in two rabbits in a series of 5 c. c. injections for 6 days. The interval between each injection was 5 days. After 30 c.c. of the sap containing virus was inoculated in each rabbit there was a gap of 4 weeks between injecting them and bleeding them for the preparation of the antiserum. The antiserum thus obtained was centrifuged and stored in a refrigerator.

The preparation of the antiserum was intended to test serologically the virus multiplication in the two sets ; the one to which normal Knop solution was given as nutrient and the other which was deficient in nitrogen. It is now proposed to carry the work further in different sets with solutions deficient in other elements.

It is also proposed to carry out another set with tobacco mosaic virus of which an infectious and purified extract is available with us and the experiment under these conditions will not have any risk of any other virus coming in as a contaminant.

13. *Research Worker's*—Dr. S. N. Das Gupta and Sri Avdhesh Narain, Department of Botany, University of Lucknow, Lucknow.

Research Project—Physiological specialization in smuts.

Studies on physiological specialization with the smut, *Sphacelotheca sorghi*, affecting *Sorghum vulgare* (Jowar) were continued. As it was mentioned in the earlier report that different nutrient media, standard synthetic medium, oat meal agar, malt extract agar and potato dextrose agar were tried for the growth of smut culture. During the course of study three different physiologic forms, Sp. A, Sp. B and Sp. C, were obtained. These three forms were distinct in their physiological behaviour from each other while grown on the four above-mentioned media.

Of all the media tried to culture these forms, oat meal agar was found to be the best and it gave most satisfactory results. From the parent culture of Sp. B few sectors were observed arising in different directions which were different from each other and the parent Sp. B in the rate of growth, colour and cultural characters. Thus four mutants Sp. B-A, Sp. B-B, Sp. B-C and Sp. B-D were isolated from the form Sp. B. While the forms Sp. A and Sp. C were found breeding true in the subsequent generations which were altogether different from each other and the forms Sp. B-A, Sp. B-B, Sp. B-C and Sp. B-D. During the course of study, mutant Sp B-A was found to be breeding true while the mutants Sp. B-B, Sp. B-C, and Sp B-D showed further mutation in their following generations which resemble with Sp. B and the mutant Sp. B-A. Efforts to isolate true mutants of these forms are carried on.

In addition to the smut *Sphacelotheca sorghi*, studies with the physiologic behaviour of smuts, *Ustilago hordei* and *Ustilago tritici* are in progress.

14. *Research Workers*—Dr. V. Puri and Sri H.P. Sharma, Department of Botany, Meerut College, Meerut.

Research Project—Morphology and anatomy of the Gnetum ovule.

During the period under review we have been able to work out anatomy of the ovule of some 15 species of Gnetum. It has been brought out that the vascular supply for the ovules in a whorl diverges out in the form of two vascular rings one inside the other. The vascular bundles of the middle ring are inversely oriented, i e. they have their xylem directed outward. Such a condition seems to have been brought about by the ovules becoming sessile. Bundles of the middle ring would form the adaxial portion of the ovule supply and would, therefore, be inversely oriented with reference to the inflorescence axis. There exists some variation with regard to this feature in different species.

15. *Research Workers*—Dr. Shri Ranjan and Sri Balkrishna Malviya, Department of Botany, University of Allahabad, Allahabad.

Research Project—Nitrogen metabolism in higher plants.

Study of the nitrogen metabolism in respect to the deficiency of minerals, especially phosphorus and nitrogen has been taken up with linseed grown in sand culture. Jamuna sand, purified by mechanical as well as chemical means, washed thoroughly in running water, was used for the experiment.

The following treatments have been planned to be given for the growth of the plants intended to the study.

1. Normal nutrient solution.
2. Solutions containing phosphorus but no ammonium nitrogen.
3. No phosphorus solution.
4. Solution containing phosphorus but without any nitrate nitrogen.
5. Solution lacking both in phosphorus as well as nitrate nitrogen, and,
6. Solution lacking both in phosphorus as well as nitrate nitrogen.

In the first experimental season, starting from November 1956, the effect of phosphorus deficiency on the nitrogen metabolism of the plant was evaluated. To start with linseed plants were raised in normal and minus phosphorus solutions separately. Plants thus raised were analysed after every 3 weeks' interval, from four random samples of twelve plants each. The metabolities of the plant were extracted by boiling and crushing the material in 80% ethyl alcohol. The two components, (i) soluble and (ii) insoluble were analysed separately.

Amino acids, organic acids and sugars were analysed by means of paper chromatography. The various amino acids, and organic acids were separated on two dimensional paper chromatograms, while the sugars were separated on circular paper chromatograms, with radial cuts, as modified in these laboratories.

Result—At all the stages arginine and glutamic acids were found to accumulate in the soluble fraction of the phosphorus deficient plants The soluble amino acids, in general, also were more in phosphorus deficient ones than in the normally fed plants.

Still more striking was the difference between the protein content of the phosphorus deficient and the control plants. It was found that the protein content of the phosphorus deficient was of a lower order than that in the control series.

Plants of the phosphorus deficient series showed less amount of malic acid as compared to the control ones, while citric acid accumulated in the former only. A correlation between the amino acids and the organic acid has been attempted to be established.

The sugars, in general, were lesser in phosphorus deficient than in the control plants.

Total and soluble nitrogen were also analysed. Total nitrogen content of the phosphorus deficient plants was lesser than that of the control ones, but soluble nitrogen/total nitrogen, ratio of the former was greater than that of the latter.

Further aspects of the problem in respect of the treatments detailed above are in progress.

Utility—The linseed plant is an oilseed plant and the relationship between the nutrition of the plant and the fat metabolism is bound to be of great utility in increasing the oil percentage of the crop.

16. *Research Workers*—Dr. Bahadur Singh and Sri Sankatha Prasad Singh, Department of Botany, B. R. College, Agra.

Research Project—Structure and development of seeds in Euphorbiaceae and allied families.

The present investigation deals with the structure and development of seeds of two sub-families, Crotonoideae and Phyllanthoideae, of the family Euphorbiaceae. The former has one ovule in each loculus while the latter has two. The plants worked out in the Crotonoideae are *Euphorbia geniculata* Orteg., *Croton sparciflorus* Morung, and *Croton tiglium* Linn. and in the Phyllanthoideae is *Phyllanthus niruri* Linn.

In all cases the ovary is tricarpellary, syncarpous, triloculer and superior with axile placentation. In *E. geniculata*, *C. sparciflorus* and *C. tiglium* each locule possesses a single ovule while two ovules are present in *Phyllanthus niruri*. The ovules are bitegmic and anatropous except in *Phyllanthus niruri* where it is more or less orthotropous. The nucellar beak is very well developed and extends always beyond the integuments except in *Euphorbia geniculata*, in which it reaches the inner integument only. The micropyle is formed by the outer integument only.

The obturator, which is a placental growth, is fairly well developed. In *Euphorbia geniculata* a portion of it projects into the micropyle and touches the nucellar beak while in others it is slightly better developed and more or less surrounds the nucellar beak.

An important feature in *E. geniculata* and *Phyllanthus niruri* is the presence of well marked hypostase which is absent in earlier stages in *Croton* sps. In the latter stages few cells differentiate around the vascular supply at the chalazal region in *C. sparciflorus* and may be compared with the cells of hypostase. It is a group of thick walled cells at the level of base of the two integuments; it persists in the mature seed more or less in a crushed condition.

The vascular supply of the ovule terminates at the chalazal end and does not extend to the free part of the nucellus or integuments in *E. geniculata* and *Phyllanthus niruri* while in *C. sparciflorus* and *C. tiglium* it branches at the chalaza and enters the inner integument reaching nearly the micropylar tip.

The development of the female gametophyte in *Croton* and *Phyllanthus* is of the polygonum type as has been reported earlier. In *E. geniculata* similar development has been found.

The endosperm is free nuclear in all cases. In *Croton sparciflorus* and *Phyllanthus niruri* the wall formation starts from the micropylar side and gradually proceeds towards the chalazal end. In *E. geniculata* the wall formation starts from the periphery first in the lower part of the embryo sac and proceeds towards the micropylar end.

Some stages of the embryo of *E. geniculata*, *C. sparciflorus* and *C. tiglium* show that the development is probably of Onagrad type as has been seen in most other genera of this family. The development of embryo in *Phyllanthus niruri* has been found to be of Solanad type and is not known in other members of this family so far investigated.

The seed coat in all the case is formed of both, the outer and inner integuments.

An important feature, in all the members of the family studied, is the presence of a sclerenchymatous layer which develops from the outer epidermis of the inner integument.

The caruncle in *E. geniculata* and *C. tiglium* is well developed and derived from the outer integument while in *Phyllanthus niruri* it is absent.

17. *Research Workers*—Dr. A. S. Srivastava and Sri Kamta Prasad Katiyar Plant Protection Service, Uttar Pradesh, Kanpur.

Research Project—Studies on chemical control of certain important pests and nematodes attacking crops with particular reference to physiological and biochemical changes induced by the application of insecticides.

An exhaustive literature survey has been carried out and most of the references on the plant parasitic nematodes have been collected and compiled. For carrying out toxicity tests against the wheat nematode, modified techniques have been developed and laboratory investigations have been carried out to control these nematodes with a number of chemicals. In this connection, an exhaustive field trial had been laid out last year under field conditions to confirm the laboratory findings. Further, the work has been progressing satisfactorily to isolate and culture pure strains of root knot nematode (*Meloidogyne* spp.) affecting different plants. The life history of these nematodes is under study.

PHYSICS

1. *Research Worker*—Dr. K. Majumdar, Physics Department, University of Allahabad.

Research Project—Investigations in optical instruments and spectroscopy of molecules.

In the study of the cool flame spectrum, it was found that the emitter was the molecule PO. Similar results obtained by other observers are being studied and compared with ours.

An extensive study of the flame spectrum of tin iodide (SnI) was taken up with a view to find out the spectrum of SnI. A well defined system in the region of 4400—5500 A° was obtained, which proved to be due to CuI molecule. The spectrum of CuI molecule has also been studied in absorption.

The vibrational transition probability for PN molecule has been calculated and a study of the same for other molecules is in progress, with a view to study the mechanism of combustion in flames.

The absorption spectrum of tin iodide has been studied in ultraviolet in low as well as high dispersion. A temperature of 300° C was found most suitable for the development of the bonds which have been obtained near 2300 A°. The analysis and determination of molecular constants is in progress.

The absorption spectrum of ZnTe molecule in the ultraviolet has been studied at a temperature of 1000 °C. One band system has been obtained, analysed and molecular constants determined.

Absorption spectrum of ZnSe in the ultraviolet at temperatures ranging from 1000°C from 1500°C has been studied extensively and three systems have been obtained. The analysis and determination of molecular constants is in progress.

The apparatus for the study of absorption spectrum of aromatic hydrocarbons has been set up and preliminary observations have been taken with toulene.

Chloro-benzaldehyde is now chosen for such a study, observations have been made at room temperature in the vicinity of 3000°A.Further study of the same at various pressures and temperatures is in progress.

2. *Research Workers*—Dr. S. S. Banerji and Sri T. V. S. Murti Engineering College, Banaras Hindu University.

Research Project—Design and development of electronic instruments.

Papers published— 1) Design and development of a simple ionospheric equipment—J. Sc. and Ind. Res. Vol. 15-A, no. 2, 74 (1956).

(2) Use of balancing resistances and cathode voltage in the design of electronic watt meters, J. Sc. and Ind. Res. Vol. 14-B, no. 7 pp. 885 (1955).

The investigations have been carried out on the design and development of two different types of instruments as mentioned below.

1. *Simple ionospheric equipment*—Design and construction of the simple ionospheric equipment has been completed and the apparatus is now being used regularly in this laboratory. The frequency range of the apparatus has been increased to 3 to 18 megacycles per second. Rectangular pulses with the duration of 100 microseconds to one millisecond can be radiated. Patent application for the equipment will be filed very soon.

The details of the equipment have been published in the Journal of Scientific and Industrial Research, Vol. 15-A, no. 2, pp, 70-74, 1956

2. *Electronic wattmeter*—Investigations have been continued on the improvement on the design and construction of the electronic wattmeters. Efforts have been made to increase the range of the instrument and the design have been considerably modified to usually used in such apparatus.

The theory of operation of the instrument has also been developed for improving the range and calibration. One paper has been communicated for publication on the variation of sensitivity and range of the electronic wattmeters.

3. *Research Workers*—Dr. P. S. Gill and Sri R. P. Saksena, Department of Physics, Muslim University, Aligarh.

Research Project—Study of heavy mesons using nuclear emulsion.

400 microns thick G5 emulsions were exposed and processed with a view to study the heavy mesons. The scanning of the plates is being carried out to get some useful information about these curious particles. Meanwhile a study of theoretial views regarding the properties of K mesons and hypersons was made.

4. *Research Workers*—Dr. S. R. Khastgir and Sri Mool Chandra, Department of Physics, Banaras Hindu University, Banaras.

Research Project—Ionospheric movements.

I. *Study of intensity variations of the echoes from the Es and F2 layers at vertical incidence.*

Employing the pulse-transmitter, the intensity variations of the R/F-pulses reflected from the Es—and F2—layers have been studied continuously for some time during early morning hours and night hours. These Es—and F2—echoes have been statistically analysed with reference to (i) the time variations in signal amplitude and (ii) the variations in the change in amplitude over a small interval of time. Evaluations of the ratio of the amplitude of the steady-reflected component to the component scattered by the ion-clouds in the Es—region and also of the r. m. s. line-of-sight velocity of the ion-clouds, have been made.

II *Construction of equipment for measuring the horizontal velocity of ionospheric winds by the method of three spaced receivers.*

(*a*) *Recording arrangement with a moving film camera*—A recording unit, enabling continuous recording of the fading of an ionospheric echo received by each of the three receivers in the three-spaced-receiver method of studying the ionospheric movements, has been developed. Cossor's Oscillograph Camera is employed for the purpose. Continuous motion of the photographic film is achieved by coupling the receiving spindle of the camera with a motor unit fitted with a reduction gear and a suitable pulley arrangement, so that the echo produces a continuous trace of its amplitude on the moving film.

Continuous records of the fading of the Es—echoes, as observed in one receiver, have been taken with the help of the above arrangement. Analysis of these records are being made and calculations of the r. m. s. lin-of-sight velocity of the ion-clouds and of the auto-correlation co-efficient are in progress.

(*b*) *Erection of three spaced aerials*—For wind-velocity measurements by the three-spaced-receiver method, three centre-fed horizontal dipole aerials, each of length 160 feet and at a height of about 25 feet from the ground, have been erected. The three aerial, with their lengths parallel, are arranged at the corners of an iso-celes right-angled triangle, having each of its equal arms 300-foot long. Ordinary twin-wire cable is used as radio-frequency feeder connecting each of the spaced aerials to the receivers.

(*c*) *Experimental arrangement for recording the amplitude variation of any one echo in the spaced-receiver method of wind-velocity measurement*—An experimental arrangement which can select any one desired echo in the three-spaced-receiver method and record the variation of its amplitude alone in the presence of the ground-pulse and other returns, is being developed. The experimental set-up comprises (i) a gate-pulse generating circuit (ii) a signal circuit and (iii) a mixer circuit. A brief description of these circuits is given below :

From the 50-cycle A/C voltage, a square-wave is generated by employing a 6SJ7-tube as squarer. The sharp pulses obtained by differentiating the square-wave are, then, utilised to trigger the flip-flop circuit which works as a cathode-coupled multivibrator, thereby producing a positive gate-pulse during each cycle. The positive gate-pulse is applied to the suppressor-grid of a mixer tube (6AC7), to the control-grid of which is applied a signal voltage from the receiver after limiting in a diode-clipper. The suppressor-grid is biased beyond cut-off, so that the mixer functions as an amplifier only during the period when the positive grate-pulse appears between the suppressor-grid and the cathode of the mixer. By means of a phase shifting net work it is thus possible to make the gate-pulse coincide with the particular echo meant for study, so that only that particular echo is amplified by the mixer all the others being suppressed.

The assembling of these circuits is in progress.

5. *Research Workers*—Dr. S. R. Khastgir, Sri Mathura Mohan Goswami, Sri S. G. Lele, Sri M P. Varma, Miss G. V. Subhadramma Department of Physics, Banaras Hindu University, Banaras.

Research Project—Ionospheric research in Uttar Pradesh.

The scheme on "Ionospheric Research in U. P." has comprised the following investigations :

I. Construction of pulse transmitter and radio receiver system for the study of ionospheric echoes.

II. Study of the interference of polarized components of the downcoming radio waves in the ionosphere.

III. Statistical study of the random amplitude variations of the downcoming waves from the ionosphere.

Study of the ionospheric echoes—The following equipment for the above work have been installed :

(i) Transmitter with a peak power of 200 watts having a frequency range from 2·5 to 25 Mc./sec.

(ii) Pulsing circuit giving sharp pulses of about 50 seconds.

(iii) Receiving system worked with a cathode ray oscillograph.

(iv) Transmitting and receiving aerials.

II. *Interference of the polarized components*—A selective aerial system was designed for the reception of one or the other of the two magneto-ionic components in the ionosphere. The left handed and the right handed components were received for the direct and reverse positions of a commutator inserted in the circuit of one of the loop aerials. Photographic records of the amplitude variations of the downcoming waves from Allahabad, as received at Varanasi at night by an ordinary loop aerial were first taken continuously on a rotating drum recorder for some minutes. Immediately afterwards, the selective aerial system was switched on and continuous records were taken for the two positions of the commutator alternately for a definite interval of time. The observations definitely showed that when a slow periodic type of fading was detected with the unpolarized receiver, the polarized receiver did not reveal the same slow periodicity. It was concluded that the observed slow periodic fading must be due to the interference of the two magneto-ionic components in the ionosphere.

III. *Statistical study of amplitude variations of the downcoming radio waves*—The time-variations of the amplitude variations of the downcoming waves from eight different broadcasting stations (Allahabad, Calcutta, Colombo, Dacca, Delhi, Karchi, Madras, Srinagar) were recorded for the purpose with a suitable receiving system. The theoretical Rice distribution curves for the amplitude variations were then drawn after computations, and made to fit with the observed distribution curves giving the ratio of the steady component reflected from the ionosphere to the root-mean-square component scattered from the irregularities in the ionosphere. Conclusions have been drawn from the above statistical study.

Utility—(i) A regular study of the innospheric echoes proviaes us with ionosopheric data which are of immense theoretical and practical value from the point of view of communication.

(ii) The experiments on the interference of the pelarixed components have yielded results of a fundamental nature. The results can also be utilised eliminating periodic type due to this king of interference of the magneto-ionic components.

(iii) The statistical study of random amplitude variations of the downcoming waves from the ionosphere has yielded confirmation of the theory of such variations. The determination of the ratio of the steady component reflected from the ionosphere to the scattered compenent will help in finding the conditions under which the random scattering from the irregularities can be reduced to a minimum. Information may also be obtained of the nature and extent of the ionospheric irregularities.

6. *Research Workers*—Dr. Putcha Venkateswarlu and Sri Ram Din Verma, Deparment of Physics, Muslim Universiry Aligar. Aligarh.

Research Project—Emission of spectrum of bromine excited in the presence ef argon.

A. Part I—The Band System in the Region 2950=2670. *A.*

Bromine was excited by an uncondensed transformer discharge in the presence of argon. The spectrum obtained was found to be different from what one gets without the presece of a foreign gas and consists of (1) a short niscrete band system in the regian 3150-2970-A, (2) an extensive discrete band system in the region 2950-2670-A, (3) a short and weak discrete system in the region 2660 2590-A and a set of diffuse bands in the region 3340-3190-A. The wavelengths and wavenumbers of the band heads of the system 2950-2 70-A as obtained from the measurements of the plates taken on the first order 21-ft. grating spectrograph are given a long with the vibrational analysis. This system is shown to be due to a transition from an upper electronic state at 51802 cm=1 with w'_e=150·5cm—1 and $w'_e x'_e$=1·15 cm—1 to the well known $^2w_s(O_n^+)$ state at 15918 cm—1.

B. Part II—The band system in the region 3150-2970A and that in the region 2660-2590-A

The wave lenths and wavenumbers of the band heads of the systems 3150—2970-A 2660—2580-A as obtained from the plates taken on the first order 21-ft. grating spectrograph are given along with their vibrational analysis. The following constants are obtained for the upper states of the two systems:

3	*Te'*	*ve*	*w'e*	*w'ex'e*
3150-2970A	48516 cm—1	32598 cm—1	162·0 cm—1	0·29 cm—1
2660-2590A	56776 „	40858 „	108·0 „	(1·50 „

These two systems have a common lower state which is the $^3\pi u(O_u^+)$ state at 15918 cm—1 and which is also the lower state of the 2950-2670-A system discussed in the early chapter.

C—Emission spectrum of iodine excited in presence of argon

The band systems of iodine in the regions 3455-3015A, 2785—2750A and 2730-2520A obtained by earlier workers using prism spectrographs are now photographed in the first and second orders of a 21-ft. grating spectrograph. A large number of new bands are recorded in all these three systems which are now extended to the regions 3461-3015A, 2783-2731A and 2729-2486A. The wavelengths and wavenumbers of all the bands are recorded along with their visually estimated relative intensities. The Deslandres schemes for the three systems representing all the bands are given and are found to be supported by the corresponding intensity distributions of the expected type. It was found that the two systems 3460-3015A and 2785-2731A do not involve for their lower levels the ground state as assumed by the earlier workers but the $^3\pi u(O_u^+)$ state at 15642 cm—1. The analysis as given by earlier workers for the 4400-4000A system which also involves the level $^3\pi(O_u^+)$ for the lower state is also included in this chapter for completeness. The band systems in the region 2730-2486A has for its lower level the ground state of the molecules as reported by the earlier workers. A reanalysis of this system made to include all the bands observed in the present experiments gave vibrational constants slightly different from these obtained by earlier workers. The vibrational constants of the upper states of the four different systems that one gets by exciting iodine in the presence of argon are;

	Te'	*w'e*	*we'xe'*	*we'ye'*
4400-4000A system	41111 cm—1	102·2 cm—1	0·34 cm—1	...
3460-3015A system	45937 „	103·7 „	0·095 „	...
2785-2731A system	51847 „	112·4 „	0·711 „	0·004 cm—1
2730-2486A system	47207 „	96·5 „	0·510 „	0·0033 „

It was found that the 3460-3015A, 2785-2731A and 4400-4000A systems of iodine are respectively analogous to the 2950-2670A, 2660-2590-A and 3150-2970A systems of bromine.

D. The emission spectrum of iodine bromide excited in the presence of argon. Part I—The band systems in the regions 5425-5360*A* 4520-4415*A* 4120-4010*A*.

I Br vapour was excited in the presence of argon by an uncondensed transformer discharge. Four band systems were obtained in the regions 5425-5360A, 4520-4415A, 4120-4010A, and 3915-3540A, of which the first three are discussed in this chapter. The wave numbers and the wavelengths of the band heads in three system as measured from the plates taken on a 3-prism stenhill glass spectrograph are given along with their visually estimated relative intensities. The three-band systems which are new, are analysed and the following vibrational constants expressed in cm—1 are obtained:

	ν_e	ω_e''	$\omega_e''x_e''$	$\omega_e''y_e''$	ω_e'	$\omega_e'x_e'$
4525-5360A	18613	65·5	0·24	—0"01	43·03	0·026
4520-4415A	22312	65·5	0·24	—0·01	77·0	0·5
5120-4010A	24540	160·58	1·125	...	128·4	0·1

The lower state of the first two systems has been identified with the (O+) state at 1681·4 cm—1 reported earlier by Brown from a study of the absorption bands in the visible region.

E. The emission spectrum of IBr excited in the presence of argon. Part.

Part II—The band system in the region 3915-3540*A*

Wavelengths and wavenumbers of the band heads in the region 3915-3540A are recorded as obtained from the measurements of the plates taken on a first order 21-ft. grating spectrograph. Earlier workers reported forty bands of the system covering the region 3900-3800A. All the bands of the system obtained in the present experiments are analysed as involving the $^3\pi$ (1) state for lower state. The constants for the lower states are such that they represent well the $\Delta G\ V+\frac{1}{2}$) values obtained in the present experiment from $v=\pi$ to $v=26$ as well as those obtained by Brown for the $^3\pi$ (1) state from he $v=9$ to $v=43$. The vibrational constants of the two systems involved are—

ω_e''	$\omega_e''x_e''$	$\omega_e''y_e''$	$\omega_e''z_e''$
137·8 cm—1	0·571 cm—1	—0·1156 cm—1	$+3·09\times10$—3

$\omega_e''t_e''$	ω'_e	$\omega_e'x_e'$
$-2·5\times10$—5 cm—1	88·2 cm—1	0·10 cm—1

The probable electronic configuration and electronic terms for the different observed states of IBr are discussed.

7. *Research workers.*—Dr. R. K. Asundi and Sri R. C. Garg, Department of Spectroscopy, Banaras Hindu University, Varanasi.

Research Project—The emission spectra of polyatomic molecules.

During this period various mono substituted benzenes ware taken up for the purpose of recording and analysing their emission spectra, connected with the electronic transition in the near ultra-violet region. The emission spectrum together with absorption spectrum puts up a complete picture electronic transition. Since the emission spectra of these molecules are not usually studied, the work was taken into hand. An account of the work done is given below :

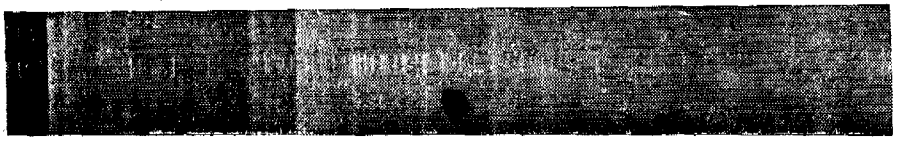
(1) *Monochlorobenzene*—Its absorption spectrum and Raman spectrum have been studied in details by H. Sponar and S. H. Wollman and J. S. Kirby Smith. A. M. Bass made unsuccessful attempts to get its fluorescene emission and conclude that the life period in the excited state is quite high, making the radiative transition very improbable As reported earlier, attempts to excite this molecule by high frequency and uncondensed transformer discharge were made by us. Various conditions were tried. However under some stringent conditions, it appears to give a very feeable emission spectrum consisting of six broad bands. The photograph was taken on Hilgers F/4 Quartz Spectrograph, which is far more effective in gathering light than any other spectrograph. However because of very low dispersion it is possible to conclude anything from it. Further work concerns with obtaining higher intensities.

2. *Monofluorobenzene*—Sponer & Wollman have studied this molecule in absorption in details. The proposed analysis corroborates $A_1 \rightarrow B_1$ tansition in the molecule. The Raman spectrum in liquid state has been studied by K. W. F. Kohlrauch and D. C. Smith and Fergusson etc. in 1953. D. C Smith and Fergusson have also studied by A. M. Bass and H. Sponar with a medium quartz spectrograph. They used condensed sparks with various metal electrodes and a number of short wavelength cut off filters to select out of line in the absorption region.

Our efforts were directed to get its emission spectrum in a high frequency or uncondensed transformer discharge. Spectrograms were taken on medium quartz spectrograph with stagnant vapour in a tube, and excited by means of uncondensed transformer discharge in presence of neon gas. C_6H_5F :

The absorption measurements give band at 37819 cm=1 2685A as (O,O), which does not appear here, as also in the fluorescence spectrogram because of the absorption by unexcited vapour, present between the window and the discharge column.

A large number of bands are, however, observed, in spectrograms taken on large quartz spectrograph, in the region (2550A° to 3000A°) when high frequency discharge was maintained through flowing mixture of vapours of C_6H_5F and n-Hexane (proportion 1 : 4). n-Hexane, spectroscopy pure was obtained from Messrs. B. D. H and used as such. Kodak O-II plates were used. There is a great extension of bands towards short wave lengths. The bands become moreand more diffuse and finally emerge into the background continuing on larger wavelength side. C_6H_5F:



Recently we have been successful in recording the emission spectrum of phenol (C_6H_5OH-solid m.p. 42°C) in a high frequency discharge on baby quartz. A large number of bands are recorded, from 2750A° towards larger wavelengths. Efforts to record it on a large-quartz spectrograph are being made. A mercury diffusion pump was used to get a proper flow of phenol vapour through the discharge tube. The fluorescence spectrum is not known. The absorption spectrum was studied by S. Kato and F. Someno. and K. Masaki.

Phenol Spectrogram (emission)

8. *Research Workers*—Dr. S. S. Joshi and co-workers, Banaras Hindu University.

Research Project—Corona pressure effect under electric discharge.

The 'corona pressure' effect (Δp) refers to a sudden and almost instantaneous increase in the pressure of a gas occurring on the application of a potential which can set up a discharge in the gas. This phenomenon first observed by Farwell, has been studied by several others, more specially Kunz, Warner, Arnold, Tyndall, Fazel, Hamburger and Eanguir. Joshi was the first to report large Δp (1-2 cm. Hg) in H_2 and N_2 under corona discharge in Siemens' tubes. Subsequently the phenomenon of Δi was discovered by Joshi. This refers to an almost instantaneous and reversible change ($\pm \Delta i$) in the discharge current due to irradiation by even ordinary light. Recently, Arnikar studied the influence of supply frequency and potential on Δp in N_2, H_2, O_2 and air over wide range of operative conditions and attempted to correlate on the basis of Tyndall's equation (*vide infra*) Δp and Δi. in a system by measuring them simultaneously. The present work was undertaken to determine the conditions favourable for the co-occurrence of Δp and Δi and to examine whether the corona pressure data can be used to understand the mechanism of the occurrence of Δi.

The results of the investigation are summarised below under four sections A, B, C and D.

(*A*) *The study of 'Corona pressure' and the 'Effect of light in H, in a Siemens ozoniser.*

The occurrence of Δp and $+\Delta i$ in H_2 obtained above 120 mm Hg. pressure, was studied for different pressures over the limited potential range possible in each case. The magnitude of $+\Delta i$ was 1-3% at all the above pressures, whereas, that of Δp was 0·2 to 1·1 mm. Hg. in the same potential range. Measurements of Δp at different potentials separately in dark $(\Delta p)_D$ and under irradiation $(\Delta p)_L$ showed that $(\Delta)p_L$ was slightly less than $(\Delta p)_D$. The values of (Δp) and $(\Delta p)_L$ occurring on the application of the discharge were found to be slightly more than the corresponding values accompanying the cessation of the discharge. At higher pressures (300—500 mm. Hg), however, the co-occurrence of Δi and Δp was not observed.

(*B*) *The 'corona dressure' and the thermionic analogue of the* Δi *in* H_2 *in a Maze type counter No.* 2

Present section reports the results for the study of $(\Delta i)_T$ (produced under action of thermo-electroes instead of light) and Δp in H_2 over the pressure range of 1—500 mm. Hg. In the lower pressure range (20—120 mm. Hg.), $(-\Delta i)_T$ was 100% at the threshold potential. At two pressures viz., 121 and 402 mm. Hg. the co-occurrence of $(-\Delta i)_T$ and Δp was observed in the potential range 5—2 to 5·7 kV. At 5·7 kV, the values were—20% and 0·12 mm. Hg for $(-\Delta i)_T$

and Δp respectively. Corresponding values at 402 mm. Hg, were —13% and 0·5 mm. Hg. At still higher pressure $(+\Delta i)_T$ and Δp co-occurred. $(\Delta i)_T$ data were also confirmed oscillographically. These results have been published. (Proc. Ind. Sci. Congress., 1955, Part III, Phy. Sec. Ab. 26).

(*C*) "*Effect of aging under discharge on the residence of Platinum electrode*"

Continued working of the Maze tube (No. 3) with progressively increasing the gas pressure in the range 1·15 mm. Hg, resulted in a reversible lowering of the normal electrical resistance of the Pt wire. The wire which could be heated to a dull reddish glow at 4A and to white glow at 5A, now did not glow even faintly at 5A, with or without discharge. Measurements showed a change of resistance of—40%. Evacuation of the tube at this stage, restored the normal resistance of the wire. Also the wire could glow now at 5A as before. Once initiated by sufficient aging under discharge, the change of resistance of the Pt wire was reversible between vaccum and even a trace of H_2.

(*D*) "*The 'Corona pressure' and the thermionic analogue of* Δi *in Maze type counter in air*"

Next the changes in the current due to the thermionic emission and external irradiation acting singly or jointly on the discharge were studied in the system air, in tube no. 3. Measurements of Δp, $(-\Delta i)$, $(-\Delta i)_T$ were carried out in the pressure range 200—450 mm. Hg. The co-occurrence of $(-\Delta i)$, $(-\Delta i)_T$ and Δp occurred at 214 mm. Hg. The effect was —100% under irradiation and also under thermionic-emission in the potential range 5·2-6·52 kV. and emission in the potential range 5·2-6·52 kV. and the magnitude of Δp was 1·0-1·5 mm. Hg in the above potential range.

The influence of the frequency of light was studied using four different filters whose peak transmissions were determined spectroscopically. The magnitude of Δi was —100% with faint green filter, —60% with blue filter, —50% with red filter and —40% with deep green filter respectively. With ultra-violet light from a quartz mercury vapour lamp, 100% negative effect was observed at 214 mm. Hg pressure, over the potential range 5·48—6·52 kV. The use of β, γ radiation from a radioactive source did not have any effect over the above potential range,

Tyndall considers Δp a thermal effect of the discharge, the sharpness of the rise being due to the electronic wind arising from the motion of the charge. Tyndall showed $\Delta p = i/4\pi k$, where i=current per unit length of the electrode and k in the specific ionic mobility. The co-occurrence of Δp, $-\Delta i$ or $(-\Delta i)_T$ can be utilised on the above relation for understanding the mechanism of $-\Delta i$). In a typical case the ratio of Kdark/Klight calculated on the basis of Tyndall's equation came to be approximately 2, under conditions of—60% Δi, thus

showing that $-\Delta i$ or $(-\Delta i)$ T is associated with a decrease in the ionic mobility, as postulated by Joshi earlier. It is interesting to note that under conditions of $+\Delta i$ observed in tube No. 1 similar calculation of $(\Delta p)_D$ and $(\Delta p)_L$ show an increase of k under light.

The observation that the change of electrical resistance of the Pt. wire (in tube No. 3) is perfectly reversible in that evacuation restores the normal resistance and admission of H^2 lowers it back again, egrees in the view that absorption like layer is formed on the electrode surface. The sudden cooling of a red hot W-wire due to application of a corona discharge reported earlier by Davis appears to be the consequence of a similar effect of a absorption of excited gas.

Corresponding studies with argon (in tube no. 8) are in progress.

9. *Research Workers*—Dr. S. S. Joshi and co-workers, Banaras Hindu University.

Research Project—Cathodic reactions in excited hydrogens.

The investigation was restricted mainly to the study of catho le fall in the present set of experiments. It is well established that the occurrence of a current supervision *i. e.* producible by irradiation of a gas discharge from extreme red to X rays (also by β, Y rays) is restricted to the neighbourhood of the threshold potential, characteristic of the incipient breakdown. This is suggested that an important factor in the machanism of $-\Delta i$ may be the changes of the cathode fall which is known to be a major deteriment of the current *i*, in a self maintain ed' discharge. There are no quantitative data on the cathode fall measurements under A. C. fields which are commonly employed in the studies of Δi. The work on the measurement of normal cathode fall (Vn) under smooth D. C. potentials is due to Guntherschulze, Skinner, Wilson and Compton.

It is shown that the values of the normal cathode fall (Vn) for each metal (Al or Pt) under unipolar discharge (30 c/s), equal those obtained under D, C. excitation as also those available in the literature Under bipolar' discharge the sum of the potential drops across either of the negative glows equalled Vn. The wave forms of the normal cathode fall resembled the corresponding wave forms of the glow current. It is suggested that the oscillation observed in glow current are related with those in the wave forms of the normal cathode fall and in either case are due presumably to the vibration of the Crookes dark space.

The potential frequency was found to have practically no effect on the normal cathode fall. Its increase over a limited range, caused a decrease in the total number of striations as also the 'abnormal' cathode fall.

Is is observed that $-\Delta i$ under 'unipolar' and 'bipolar' discharge, is associated with corresponding suppression, under irradiation of the cathode fall. It is known from the general theory to be due to a certain distribution, in the discharge space, favourable for the maximum ionization. This supports the idea that $-\Delta i$ is also a space charge effect.

Admission of traces of Cl_2 in H_2 causes a suppression of the normal cathode fall and the negative glow, along with a marked decrease in the current. The action of light has been found to be similar, suggesting thereby a common mechanism for the both. This mechanism involves the formation of a negative ion space charge by attachment of electrons to neutral atoms.

Admission of alcohol vapour into H_2 has been found to cause a marked decrease in the (i) abnormal cathode fall, (ii) the abnormal current, (iii) the width of the Crookes dark space and (iv) the total number of striations The above decrease was found to be accentuated by the additions of more amount of alcohol vapour. It appeared that the admission of alcohol vapour resulted in its decomposition and subsequent formation of numerous excited atoms, which thus destroy the striations. The lowering of the abnormal cathode fall is attributed to the decrease in the density of the positive ion space charge. Such a decrease should be caused by the distribution of the possitive ions of H_2 by alcohol molecules through a process involving the transfer of an electron from a molecule to the ion as shown by Korff[5].

The inversion of $+\Delta i$ to $-\Delta i$ observed after the admission of alcohol vapour, in stages, is attributed to certain surface phenomena, which are assumed to be responsible for the photo-sensitivity of G. M. counters noticed by earlier workers. The process invol es the formation of active centres which undergo a chemical change with the admission of electrons or ions especially under irradiatian leading to $-\Delta i$.

10. *Research Worker*—Dr. P. G. Deo, Department of Physics, Lucknow University, Lucknow.

Research Project—Studies of etching of metal and allows (Babbik) crystals under cathodic sputtering by multiple beam interferometry and offer recent optical techniques.

Papers published—(1) Structure sensitive properties of solids and dislocations——Uttar Bharati, Vol. 2.

(2) Differential sputtering of grains boundaries in polycrystalline tin——Nature, Vol. 178. 1956.

The scheme aimed at investigating the structural characteristics of metal and alloys as revealed by etching under cathodic sputtering using recent optical techniques. For this purpose the polished metal and alloy specimen were to be etched and microphoraphically examined.

Investigations were carried out on the etching of polycrystalline tin and Babbik (Sn-Sb) alloy. Some very interesting results regarding the structure of grain boundaries, their movement and distribution of atoms along were made.

MATHEMATICS

1. *Research Workers*—Prof. V. V. Narlikar, and Sri P. C Rath, Department of Mathematics, Banaras Hindu University, Varanasi.

Research Project—"Why is the force between mass and mass attractive ?"

"Why is the force between mass and mass attractive?" This question has remained unanswered, both in Newtonian and relativistic theory of gravitation. In electromagnetism, one encounters attraction as well as repulsion, there being negative and positive charges and poles, which are either like and unlike. It is, however, a mystery of nature that although inertial masses of elementary particles show a great diversity in value, they are always alike in sign, i.e. they are always positive. This fact has been more or less tacitly assumed in general relativity. Nevertheless it is believed that a strict theoretical justification of this, can be given with the help of the more fundamental postulates of relativity. Recently a number of attempts have been made by relativists to advance consistent theories as to why do we not encounter negative masses in nature. For this references can be made to—

(1) B. Hoffman, *Phys. Rev.* Vol. 47; 1935; p. 877.

(2) Einstein and Rosen, *Phys Rev.* Vol. 48; 1935; p. 73.

(3) Hoffman and Infeld, *Phys. Rev.* Vol. 51; 1937, p. 765

(4) C. Lanczos, ,, ,, Vol. 59; 1941; p. 703.

(5) Narlikar V. V., *Curr. Sc.* no. 10; 1941

(6) Ray Chaudhuri, *Phys. Rev.* Vol. 48; 1951; p. 166.

The above works are examined critically and the following observation made:

(1), (2) and (3) suggest that the positive sign of inertial particles can be accounted for, whenever it is possible to obtain regular solutions of field equations. Such situations do not arise in general relativity. Some more information regarding the electrical nature of matter has to be assumed or awaited for. Infeld (3), for instance, introduces a characteristic length r_0, given by

$$r_0=(e/b)^{\frac{1}{2}}$$

where e is the elementary change, and b the fundamental field-strength in his theory. On account of this additional hypothesis, it has been possible to obtain a regular gravitational field for the fundamental electric particle, thus showing that the gravitational mass and electromagnetic mass are essentially the same, and that gravitational mass cannot be negative. On introducing r_0, one has to go beyond general relativity to accept the Born Infeld theory of electro-magnetism, which amounts to inviting many more difficulties for the avoidance of one.

Lanczos (4) has given reasons for his additional assumption

$$R=0$$

inside matter, to show that inertial particle are of the second order of smallness and positive. This procedure is unsatisfactory on account of the new numerical relation that follows between the inertial and gravitational masses.

The claim of Prof. Narlikar (5) that 'gravitation is deducible within the framework of relativity is convincing although his proof is only partial It seems quite plausible that the limit associated with the inertial mass (i. e. $m > 0$) should be inextricably linked with such well-known facts as the velocity of light, modified by the gravitational field not exceeding unity in natural co-ordinates and

$ds^2 > o$, where $ds^2 = g_{\mu\nu}\, dx_\mu\, dx_\nu$ is the metric associated with the gravitational field.

One of the problems that has engaged attention is the co-ordination of these limits.

It is further observed that $m > o$ is also linked with p and P, where p and q are the pressure and energy density of the configuration. There by the enquiry is shifted but the difficulty is not removed.

The gravitational field of a distribution of Fermi's electronic gas is examined, with a view to apply relativistic correction to a known result (in the theory of Stellar Structure) concurring super dense stars and incidentally a rigorous proof of Oppenheimer's theorem is also attempted. The investigation is yet incomplete.

2. *Research Workers*—Dr. V. V. Narlikar and Sri Daya Nand Verma, Banaras Hindu University, Varanasi.

Research Project—The problem of motion in general relativity and the unified field theories.

Calculations were made to check the conjecture of the existence of an upper limit for the quantity a^2P for celestial bodies (a—radius, P—density), found theoritically to be of the order of 10^{23} gm./cm. From the limited data at hand it was verified that generally this quantity does not exceed 10^{22} gm/cm., the greatest value obtained being in the case of Sirius B, viz., 3.10^{23} gm./cm.

The problem of correction to the effective mass of a gravitating body, which is closely connected with the above mentioned conjecture, was also studied. The Newtonian correction based on the energy-mass equivalence of special relativity, already obtained much earlier was revised, and the possibilities of obtaining an exact correction based on general relativity methods were studied.

A thorough study of the method of variation of the gravitational potentials was made. A criticism of an earlier definition of 'stationary' fields based on this method was obtained. Alternatively a definition of an 'isolated' gravitational field free from that criticism was laid down. A mathematical investigation for such fields was carried on. Most of the simple well-known fields are suspected not to be isolated. Variations of the trivial field viz., flat space-time consistent with the field equations for empty space were investigated and the field equations obtained were partially solved. The geodesics in a 'nearly' flat space-time were studied and some interesting results were found.

A study was made of the physical estimation of the constants G and C (gravitational constant and the velocity of light) and of the possibility of their not being true constants.

Two point tensor notation was developed, initially to explore possibilities of using it in the two-body problem and later on as a separate formalism leading to a greater generalization of the usual theory of parallelism defining an Affine Geometry. A number of interesting features were observed in developing the notion of parallelism in a "bi-space" with the usual notion of parallelism. An important finding was that transformations leading to "normal" co-ordinates of the "bi-space" do not always exist. A set of sufficient conditions for their existence was obtained.

The new jump conditions in general relativity given by Synge were carefully studied and certain modifications were thought upon.

A study of the unified field theory of Einstein and others was initiated. Acquaintance was made with Hlavaty's approach. A new field theory of Eisenhart was examined and a study is being made of some inconsistencies which are suspected in the formalism.

3. *Research Workers*—Dr. P. L. Srivastava, and Dr. Snehlata Nigam, Department of Mathematics, University of Allahabad, Allahabad

Research Project—Studies on generalised Laplace Stieltzes Integral.

(i) An effort has been made to extend the work on generalisation of Laplace integrals to include three variables. The results are embodied in a paper captioned, "On Laplace Transform involving three variables."

(ii) A few theorems on generalisation of Laplace Stieltzes Integral have been given. The results are embodied in a paper.

4. *Research Workers*—Dr. S.M. Shah, Dr. Nisar Ahmad Khan and Sri C. R. Marathe, Department of Mathematics, Muslim University, Aligarh.

Research Project—Distribution of eigen-values of matrices, quasi-idempotent matrices.

Paper published by Dr. S. M. Shah

Exceptional values of entire and meromorphic functions II *Journal of Indian Mathematical Society*, Vol. XX (1956) pp. 315-27.

Papers published by Sri C. R. Marathe

1. Some matrix equations involving the auxilliary unit matrix, (accepted for publication in the *J. of the University of Bombay*).
2. A note on a problem of Turan (accepted for publication in *American Mathematical Monthly*).
3. A note on bounds of characteristic values of products of two matrices (accepted for publication in *Quarterly of Math.*
4. A note on characteristic values of products of matrices (accepted for publication in *American Mathematical Monthly*).
5. On certain moduli of a rectangular matrices (accepted for publication in *Royal Society of Edinburgh*).
6. On semi-moduli of matrices (accepted for publication in *American Mathematical Monthly*).

Papers published by Nisar Ahmad Khan

1. The characteristic roots of the product of matrices, *Quar. J. of Maths.* (Oxford) 2), 7 (1956) 133—43.

2. On involutory matrices, *Am. Math. Monthly*, 63 (1956) 704—709.

3. The characteristic roots of products of matrices, *Proc. Ind. Acad of Sciences*, Vol. 45 (1957), Section A 84—88.

4. Characteristic roots of semi-magic square—shortly to appear in *Am. Math. Monthly*.

A square matrix Q over the complex field is said to be q.i.p (read quasi idempotent) there exists a γ matrix F (γ) such that.

$$Q^r = F(r),\ r=1, 2,...$$

All idempotent matrices are q.i.p. while the converse may not hold. Interesting properties of these matrices have been proved and applications indicated.

A modulus of a rectangular matrix is defined and with its help theorems on distribution of characteristic roots have been proved.

5. *Research Workers*—Dr. R.P. Agarwal and Sri Krishna Ji Srivastava, Department of Mathematics, Lucknow University, Lucknow.

Research Project—Fractional integration and the $\omega u \gamma$ transform.

In this paper the author has applied the operators of fractional integration and differentiation given by H Kober and A Erdelyi to develop the theory of the transform and to draw out a relationship between this and the well known Hankel's transform.

6. *Research Workers*—Dr. Ram Ballabh and Sri C. D. Ghildyal, Department of Mathematics, Lucknow University, Lucknow.

Research Project—Self superposable steady flows of the type $W = \lambda q$.

It is found by Ballabh (1940) that the Beltrami flows $W=\lambda q$ are self-superposable. The proportionality factor λ can be in general a function of x, y, z and time. It has been established by Ballabh that λ is an absolute constant if it is assumed to be a function of one space variable and time only in the case of unsteady flows. In this paper author has attempted to find out the steady flows for which λ is, in general, taken a function of all the space variables and finds that it should be zero in case of steady flows of a viscous fluid.

ZOOLOGY

1. *Research Workers*—Prof. S.C. Verma and Dr. P.D. Srivastava, Zoology Department, University of Allahabad.

Research Project—Nutrition in phytophagous insects.

The authors have published two papers embodying their results on this subject. The summaries of these papers are given below :

(i) Studies on the choice of food-plant and certain aspects of the digestive physiology of the larvae and adults of *a thalia lugens proxima* (Klug) and *Epilachna vigintioctopunctata* (F).—*Bulletin of Entomological Research*, Volume 48, 289 (1957).

Athalia lugens subsp. proxima (Klug) is a pest of cruciferous crops, and shows special preference for turnip.. In the matter of selection of food, smell and taste of the food and the age of the plant are important factors. *Epilachna vigintictopunctata* (F.) is a pest of solanaceous plants, particularly brinjal. In this insect only smell and taste are important factors in the selection of food.

The hydrogen-ion concentrations of the salivary gland, foregut, midgut and hindgut of the larva of Athalia are 6.4—6.6, 6 4—6.8,6.6—6·8 and 7·0 and of the adults 6·2—6·4, 6·4—6·6, 6·4—6·6 and 6·6, respectively. The hydrogen-ion concentration of the salivary gland, foregut, midgut and hindgut of the larvae of Epilachna are 5·4,6·4—6·8, 6·0 and 6·0 and of the adult 6·6—6·8, 6.2,6·0 and 5·4—5.7, respectively.

The foregut and hindgut of the larvae and adults of Athalia and Epilachna do not secrete enzymes; the salivary glands of both larva and adult of Athalia secrete amylase, the midgut epithelium of both larva and adult of Athalia secretes amylase, maltase, invertase, lactase, lipase and protease. The salivery glands of the larvae of *Epilachna* secrete amylase, but those of the adult do not, and the midgut epithelium of both larva and adult secretes amylase, maltase, invertase, lactase and protease. The midgut of both larva and adult of *Epilachna* secretes lipase also, although in the adult no more than traces are detectable. The proteases in both insects act in slightly acidic media.

(ii) *Studies on the feeding habits and certain aspects of the digestive physiology of different stages of Papilio demoleus Lin., Proceedings of the National Academy of Sciences, India*, 1955, *Vol.* 25, *page* 53.

Summary—(i) *Papilio demoleus* is a pest of the family Rutaceae more particulary of Citrus sp. mainly in nurseries and the larvae show special preference for orange leaves. In the matter of selection of food, odour, taste and age of the plant play important roles in the case of larvae and odour and taste alone in case of adults.

(ii) The hydrogen-ion concentration of the foregut of the larva, pre-pupa, I day old pupa, 2 days old pupa, 3 days old pupa, late pupa and adult are 9·5, 6·8, 6·4, 6, 6·8, 6·2, and 6 respectively, of midgut 8.8—9, 7, 6.4, 6.6, 6.8, 6.2—6.4 and 6.2 —6.8 respectively and of hindgut 6.4—6.6, 7, 6.4, 6.6, 6.8, 6.2 and 6 respectively.

(iii) The foregut and hindgut of the larva, prepupa, pupa and adult do not secrete any enzyme. The salivary gland of larva, prepupa and adult secrete amylase. The midgut of larva prepupa and pupa up to the age of 3 days secrete amylase, maltase, invertase, lactase, lipase and protease. The midgut of late pupa and adult both secrete only invertase. The proteases act in a slightly acidic media.

The Research Assistant, Dr. P. D. Srivastava, obtained D. Phil. degree on this work from the University of Allahabad.

2. *Research Worker*—Dr. Uma Shankar Srivastava, Zoology Department, University of Allahabad.

Research Project—Morphological, physiological and bionomical studies in the metamorphosis of certain stored grain pests.

Two pests were chosen for the above study, i. e. *Tribolium castaneum and Sitotroga cerealella* belonging to the orders Coleoptera and Lepidoptera respectively. During the year under review, a special study was undertaken of the changes occuring in the morphology, histology and digestive activity of the midgut of these insects. The structure and enzymatic activity of the midgut in the larval and the adult stages have, therefore, been studied and the results are being verified. Some interesting conclusions regarding the feeding requirements in the two stages of these insects are expected to be arrived at from this work.

3. *Research Workers*—Dr. H. R. Mehra and Sri Gyan Prakash Jain, Zoology Department, University of Allahabad.

Research Project—Investigations of the life-history of digenetic trematodes of the families Echinostomatidae, Diplostomidae and Strigeidae.

The life-history of a new species paryphostomum mehrai (Faruqui) has been studied and the various stages described. It has been found experimentally that rabbits and white rats serve as the definite host and the Snail *Indoplanorbis exustus* serves at the first and second intermediate hosts.

The inter-molluscan phase of the life-cycle involves the gradual development of the miracidium larva into a motherrediae. The motherrediae undergoes further development and produces daughter-rediae. The daughter-rediae settles in the liver mass, and when gets matured produces cercariae. The entire process takes about eight weeks viz. from the entry of the miracidium until the cercariae are matured.

The mammalian phase of the life-cycle involves the feeding of cysts to the final host. The Metacercariae develp into the adult in the intestine of the host in a period of twenty days after which the adult begins to lay their eggs. The adults belonged to the genus Paryphostomum (Dietz).

The eggs are quite unmatured when passed out and takes about a fortnight to hatch. The 18 epidermal plates are arranged in number of 6, 6, 4 and 2 in four rows, The excretory system consists of only one pair of flame cells. The germinal cells occupy the posterior two third part of body.

It has been observed that domestic animals (cattle in particular) die more commonly from helminth parasites than from other diseases.

The life-history studies of the digenetic trematodes will be helpful in the control and eradication of the disease caused by these parasites. The studies, therefore, are of great practical utility and economic importance.

The Research Assistant, Sri G. P. Jain, incorporated this work in his thesis on which he got his D. Phil. Degree.

4. *Research Worker*—Dr. D. R. Bhattacharya and Sri Krishna Swaroop, Zoology Department, C. M. P. Degree College, Allahabad.

Research Project—Fish fauna of Allahabad.

During the tenure of this scheme, a general survey of the rivers and ponds of the district of Allahabad had been made. Collections of fishes had been made throughout the year and particular attention had been paid to the fluctuations in the catch of the common food fishes, Hilsa ilisha which constitutes a major proportion of the catch during the rainy season had been found to be only a migratory fish and is not generally found after the winter sets in. But the fish has been collected throughout the year. Mature specimen of the fish had been collected in which the ova and the spermatic fluid had been oozing out. Such collections followed by the collection of juvenile forms of the fish goes on to prove that it breeds somewhere here in the vicinity.

A detailed list of fishes is being attached as appendix :

1.	Clupisoma garua ...	2.	Clupisoma murius.
3.	Clupisomar, atherinoides ...	4.	Eutoropiohthys vacha.
5.	Ompok bimaculatus ...	6.	Ompok pabda.
7.	Silonia silundia ...	8.	Colisa lalius.
9.	Colisa chuna ...	10.	Oxygaster gora.
11.	Oxygaster phulo ...	12.	Oxygaster bacaila.
13.	Chelon corsula ...	14.	Chagunius chugunio.
15.	Tortor ...	16.	Puntius ticto.
17.	Puntius sophore ...	18.	Notopterus chitala.
19.	Notopterus notopterus ..	20.	Channa gachua.
21.	Mystus cavasius ...	22.	Mystus aor
23.	Mystus singhala ...	24.	Mystus bleekeri.
25.	Mystus tengara ...	26.	Mystus beletius bila.
27.	Puntio stigma ...	28.	Bagarius bagarius.
29.	Xenentodon cancila ...	30.	Mastacembelus armatus.
31.	Mastacembelus parachus ...	32.	Ambassis nama.
33.	Ambassis ranga ...	34.	Rohtee cotio.
35.	Labeo calbasu ...	36.	Labeo bata.
37.	Labeo rohita ...	38.	Labeo caeruleus.

39.	Labeo stoliczkae ...	40.	Labeo gonius.
41.	Catla catla ...	42.	Hilsa ilisha.
43.	Gadusia chapra ...	44.	Setipinna phase.
45.	Glossogobius guiris ...	46.	Sciaena coitor.
47.	Pama pama ...	48.	Ophicephalus pseudomamtins
49.	Ophicephalus marulius ...	50.	Ophicephalus gachua.
51.	Ophicephalus punctatus ...	52.	Amblypharyngodon mola.
53.	Labauca alpar ...	54.	Dorosoma manimma.
55.	Pellona elongata ...	56	Tenarchopterus buffoni.
57.	Anguilla bengalensis ...	58.	Tetrodon cutcutia.
59.	Aila coila ...	60.	Barilius barila.
61.	Aspidoparia morar ...	62	Barilius bola.
63.	Cirrhina fulungu ..	64.	Cirrhina reba.
65.	Cirrhina mrigala ..	66.	Nemachibus botia.
67.	Botia gheto.		

5. *Research Worker*—Prof M. S. Mani, Sri Santokh Singh and Sri V. K. Gupta. Department of Zoology, St. John's College, Agra.

Research Project— *a*) Research on parasitic Hymenoptera.

The Research Assistant (Sri Gupta) has sorted out a good deal of material out of collection of nearly 300 unnamed specimens of Ichenumonidae from Malaya and has classified into sub-families and tribes. He has also identified the parasites attacking the tobacco stem borer (*Gnorimoschema heliopa*) in Gujrat (received from Agriculture Institute, Anand) as belonging to a new species of the genus Chelonus, and has described it under the name *C. heliopae*.

(*b*) Gall midges.

A large number of specimens of gall midges were collected from the Himalayas in the course of the entomological expedition to the Upper Chenal and Ravi Valleys.

Descriptions of the following species have been finalised :

Lestremia Indica, Contarinia pulcherrima, Trichoperris pipericola, Oribremia, multifida, Epidosis indicus, Schizomyia assamensis, Asphondylia lantanae, A phyllanthi, Contarinia caudata, Mycodiplosis indica, Raodiplosis orientalis, Orseolella apludae, Horioiplosis fici, O. graminis, Camptomyia ricini, A. pongamiae, A. sbeckiae. Comptomyia hibisci, C. Morindae, Schizomyia maeruae, A. ipomeae. Lasioptera erichloae, Hormomyia subaptera, Contarinia andropogonis, Hallomyia iris, Clinodiplosis ceylonicus, Plutodiplosis magnificus. Chrysodiplosis squamatus, Lestodiplosis ceylonicus, Epidosis ceylonicus, Lestermia ceylonicus, Colpodia fletcheri, Harpomyia indica, Indodiplosis mangiferae, Stretoliplosis indica, Dasyneura gossypii, A. sesami, Winnertsiola burmitica, Dentifibula ceylonica, Siphidtplosisfuina, Lowiola costata, Arodiplosis coccidivora, Dentifibula obtus ilobae, Lasioptera facata, L. paniculi, Endaphis hirta, harmomyia ischaemi, Dasyneura mangiferae, Schizobraemia malabarensis, Lopesiella pollinae.

6. *Research Workers*—Prof. M. S. Mani and Sri V. K. Gupta, Department of Entomology, St. John's College, Agra.

Research Project—Taxonomy and biology of parasitic Hymenoptera.

Papers published :

(1) Bhatnagar S P. 1948. Studies on *Apanteles, Indian J. Ent.*, 10 : 134-203.

(2) Bhatnagar, S. P. 1951. Descriptions of some known and new chalcidoidea from India. *Indian J. agric. Sci.*, 21 (2) : 155-178.

(3) Bhatnagar, S. P. 1950. Description of a new chalcid of the ber fruitfly from India. *J. Zool. Soc. India*, 2 : 135-136.

(4) Rao, S. N. and Chandy Kurian. 1951. Description of known and new Ichneumonidae from India. *Indian J. Ent.*, 12 : 167-190, 13 : 65-78.

(5) Rao, S. N. Four new species of Platygasteri parasites of gall midges. *Eec. Indian Mus.*, 48 (3-4) : 1-10 (1950).

(6) Rao, S N. Redescriptions of *Scelio hieroglyphi* timb. an egg parasite of *Hierolyphus hunian* and *H. nigroepletu* from India *J. Zool Soc. India*, 3 (2) : 239-241.

(7) Rao, S. N. 1953. On a collection of Ichneumonidae from the Indian Forest Research Institute, Dehra Dun. *Indian Forest Rec.* (Ent.) 8 (8) : 159-225.

(8) Rao, S. N. 1953. Description and notes on parasitic Hymenoptera from India, *Indian J. Ent.*, 15 : 23-28,

(9) Mani, M. S. and Chandy Kurian. Descriptions and records of chalcidoidea from India. *Indian J. Ent.*, 15 (1) : 1-21.

(10) Chandy Kurian. 1952. Four new species of chalcidoidea from India. *Agra Univ. J. Res.* (Sci.) 1 : 55-62.

(11) Chandy Kurian. Descriptions of new and records of known Bethylids from India. *Agra Univ. J. Res.* Sci.) 1 : 63-72.

(12) Chandy Kurian. 1953. Descriptions of new and records of some known parasitic Hymenoptera from India. *Agra Univ. J. Res.* (Sci.) 2 : 113-123.

(13) Chandy Kurian. 1953. Descriptions of new chalcid parasite of midge of echinate gall on mango leaf. *Agra Univ. Res. J.* (Sci.) 2 : 241-246.

(14) Chandy Kurian. 1953. Descriptions of some new chalcids from India. *Agra Univ. J. Res.* (Sci.) 4 : 119-134.

(15) Chandy Kurian. 1954. Catalogue of Oriental Bethyloidea *Agra Univ. J. Res.* (Sci.) 3 : 253-238.

(16) Chandy Kurian. 1954. Description of new and records and redescriptions of known Bethyloidea from India. *Agra Univ. J. Res.*, (Sci.) 3 : 417-440.

(17) Chandy Kurian. 1955. Bethyloidea from India. *Agra Univ. J. Res.* (Sci.) 4 (1) : 67-155.

(18) Gupta, V. K. 1955. On a new species of Chelonus from India. *Agra Univ. J. Res.* (Sri.) 4 : 209-212.

(19) Gupta, V. K. 1955. Ichenmonidae from the Himalayas *Agra Univ. J. Res.* (Sci.) 4 (2).

The work may be considered under two sections. (i) Taxonomy of Chalcidoidea. A number of important genera and species, inadequately described by earlier workers, were carefully revised on modern taxonomic lines. A large number of new species, attacking a variety of important insects, were also named and described. The material for study was received chiefly from the Indian Forest Research Institute, New Delhi. The Chalcidoidea associated with Ficus spp. in India received separate attention.

(ii) Taxonomic studies on other important groups included a series of descriptions of new forms parasitising important insect pests of forestry and belonging mainly to the Ichaemonoidea by Dr. S. N. Rao Bhatnagar, made a special revision of the Indian Apanteles Forest. and also published a detailed host parasite index. Rao and Kurian described several new species of ichneumonids. Kurian also made a special study of the taxonomy of Bethyloidea and published a comprehensive taxonomic catalogue of the group from the Oriental region. Gupta is engaged in a study of the ichneumonids from Malaya and from the Himalayas.

7. *Research Workers*—Dr. S. N. Mehrotra, Department of Zoology' Banaras Hindu University, Varanasi.

Research Projects—The annual History of the interstitial cells in the gonads of reptiles.

It has been noted that the seminiferous tubules are replenished after the end of the breeding season by the interstitial cells. These interestitial cells enter the tubules through the *Tunica propria* in large numbers.

8. *Research Workers*—Dr. S. K. Dutta, D. Sc. and Sri A. S. Kapoor, Department of Zoology, University of Allahabad.

Research Project—Nutritional value of common food fishes of Uttar Pradesh and the percentage of oil in their livers.

It was deemed proper to pay primary attention to the determination of the percentage of yield of oil from livers of fishes and to proceed with the chemical analysis of the oils thus obtained with a biological standpoint. A considerable time was spent earlier in the consultation of the literature and evolving suitable methods for the extraction and analysis of the liver oils.

The Hilsa fishes chosen for experimental work were collected for the purpose from the Ganges waters locally. The Hilsa fishes have been found to give a percentage value of liver weight to body weight ranging from the lowest value of 1·3 per cent to the highest of 1·88, per cent including within this range such values as 1·73%, 1·408%, 1·55%, 1·47%, 1·42%, etc. the minor deviations in these values partly found to be due to the size and weight of these fishes. The value of the percentage of the weights of the liver oils to the weights of the liver mass has been found to range from 7·9 per cent.

The oil has been extracted by the solvent extraction method using petroleum ether for the purpose. The oil is of brown (at times of a slightly darker brown) color. The iodine value of the oil has been determined and is found to range from 67·7—34 5. The saponification value has been found out to be 223. The acid value too has been estimated and comes out to be 69.

The presence of the vitamins A and D has been detected and the quantitative estimations of those by the colorimetric and chromatographic methods is under progress.

9. *Research Workers*—Dr. S. K. Dutta, and Sri A. S. Kapoor, Department of Zoology, University of Allahabad.

Research Projects—Lateral line and head canal sense organs in fishes.

It has been planned to work out in detail, the topography, general morphology, anatomy, and a certain part of the cytology (so as to include the occurrence and the mode of disposition of the golgi bodies and the mitochondria in the various cells of the canal sense organs) in certain teleostean fishes belonging to the family Siluridae. As such, at the outset, *Mystust cavasius* and *Heteropneustes fossilis* were selected as the types, but with the progress of the work, it was found convenient to include *wallagonia attu* also on this list.

The problem on the lateral line canal sense organs, is altogether a new subject and so far as the literature on the work is concerned, nothing is available in India. In the beginning, attempts were made for the collection of relevant literature pertaining to the subject. The tissues in the region of the main lateral line canal in both *Mystus cavasius* and *Heteropneustes fossilis* have been sectionised with histological and cytological techniques.

10. *Research Workers*—Dr. S. M. Das, and Dr. S. K. Moitra, Department of Zoology, Lucknow University, Lucknow.

Research Project—A scheme for fundamental investigations into the correlation between fish food (plankton and bottom fauna), and hydrological factors in ponds and tanks/fisheries in Uttar Pradesh, and environmental factors affecting fish-food in U. P.

Papers Published—(1) Some new observations on the circulatory system of *Ophicephalus striatus* block. (Actinopterygii ; Percomorphi) by S. M. Das and D. B. Saxena, reprinted from *Current Science*, April, 1954, 23, 127-128.

(2) New observations on the afferent branchial system of *Heteropneustes fossilis* block. (Actinopterygii ; Ostariophysi ; Siluroidea), by D. B. Saxena, *Current Science*, November, 1954, 23,363.

(3) Studies on the food of some common fishes of Uttar Pradesh, India by S. M. Das and S. K. Moitra, Proceedings of the *National Academy of Sciences India*, Allahabad, Vol. 25, Sec. B, Parts I-II, (1955).

(4) A case of convergent evolution from fish to amphibian stage, *Science and culture*, Vol. 20 p. p. 560-561, May, 1955.

(5) Fish mortality in some lakes and tanks of Lucknow, Uttar Pradesh, *Science and Culture* Vol. 21, pp. 312-313, November, 1955.

(6) Flowering of volvox in a fresh-water lake in Lucknow, India, by S. M. Das and V. K. Srivastava, *Current Science*, October, 1955, 4, 842-343.

(7) Feeding habits of fresh-water fishes of Uttar Pradesh, by S. M. Das and S. K. Moitra, *Current Science*, December, 1955, 24, 417, 418.

(8) Connition factor in some fishes of Lucknow, Uttar Pradesh by S. K. Moitra, *Current Science*, 1956.

(9) Benthic organisms of a fresh-water fish-tank, by Vinay K. Srivastava, *Current Science*, May 1956, 25, 158-159.

(10) On the afferent branchial system of Mastacembelus armaus, *Rita rita* and *Anatas testidineus* (Teleostomi) by Devendra B. Saxena *Proceedings of the National Academy of Science* (India), Allahabad. Vol. XXVI, Sec. B, Part II, 1956.

(11) Some new observations of plankton from fresh-water ponds and tanks of Lucknow, *Science and Culture*, Vol. 21, pp. 666-467, February, 1956.

(12) On the afferent branchial arteries in *Ophicephalus punctatus* Block. (Actinopterygii; Percomorphii), *Science and Culture*, Vol. 21, pp. 677-678, May, 1956.

(13) Circulation of blood in the respiratory region of the fishes *Labeo rohita* and *Ophiceyh-lus straitus* by S. M. Das and D. B. Saxena, COPEIL, 1956, 2 pp. 100-109.

(14) Quan titative studies on fresh water plankton : I-Plankton of a fish-tank in Lucknow, India by S. M. Das and V. K. Srivastava. *Proceedings of the National Academy of Science* (India), Allahabad, Vol. XXVII, Sect. B, Part II, 1956.

(15) On the afferent branchial arteries of *Anabas testudineus* and its similarity with that of *Ophicephalus striatus* by Devendra B. Saxena, *Current Science*, 1956, 15, 227-228.

(16) Arrangement of afferent branchial arteries in *Anabas testudineus*, by Devendra B. Saxena, *Current Science*, March, 1956, 25, 87-88.

(17) On the afferent branchial system of *Mastacembelus armatus*, *Rita rita* and *Anabas testudineus* (Teleostomi), by Devendra B. Saxena, *Proceedings of the National Academy of Science* (India), Allahabad. Vol. XXVI, Section B, Part II, 1956.

(18) On the afferent branchial system of *Mastacembelus armatus*, *Rita rita* and *Anabas testudineus* (Teleostomi), by Devendra B. Saxena, *Proceedings of the National of Academy Science* (India), Allahabad, Vol. XYVI, Section B, Part II, 1956.

(19) Fishes of Lucknow, Uttar Pradesh, India, *Uttar Bharti*, Vol. 3(1), 39-54, 1956.

More than 600 specimen belonging to 35 species of fish of different sizes were collected so far, locally, from different water sources in order to study their food habits. Preliminary examinations of the

stomach contents of some fresh water fishes obtained from the local market were also made.

Detailed qualitative, quantitative and gravimetric estimations of the food of the fishes were made. On the basis of these studies the food habits of the fishes were determined and the fishes were broadly separated into three major groups—the herbivorous, the omnivorous and the carnivorous fishes. Out of 35 species examined so far 9 were found to be herbivorous, 12 omnivorous and 14 carnivorous. Their standard food-affinities and deviations of these fishes have also been observed.

It has been found that the food of a particular species may vary according to different geographical and ecological conditions. We found the same species (*Barbus stigma*) is completely herbivorous in Bengal (Sen, 1937, Curr. Sci.) but omnivorous in Lucknow. This has been supported by the Russian Zoologist (T. Orlov, Director, Academy of Sciences, U. S. S R.) in his remarks on our paper in the Science Congress, 1955, who found Gambusia refusing to feed on mosquito larvae in the Moscow Region, although it is a voracious larva feeder in the Caspian Region.

The seasonal variations of the food of some of the fish-species have also been determined but studies on the variations in other species are still in progress.

The weight-length relation (K-factor) has been investigated by means of the familiar 'Condition factor' obtained from the formula, $K = \frac{100-W}{L}$. The value of this factor has been worked out for many of the fishes of U. P. and correlated with feeding habits.

After the onset of the first rains a large number of the surface feeding fishes perished each year. Some of the causes of the mortality have been ascertained.

The results of our preliminary investigations show that in most of of the economically important species, the optimum amount of food for rapid growth is available only during a short period of the year. *Labeo rohita*, *Cirrhina mrigala*, *Cirrhina reba*, *Labeo Calbasu* (July to October), *Eutroplichthyes vacha* (September), *Rita rita* in November. Thus in some of the tanks the growth of some of the economically important food fishes are slow and in some cases stunted. The application of fertilisers to such tanks in order to increase the production of fish food may considerably improve the growth of fish. It is suggested, therefore, that further studies after the use of fertilisers be carried out on fresh water ponds and tanks, which will surely yield valuable results of practical utility in due course.

The work on the food of fry and fingerlings of the common food fishes of Uttar Pradesh has yet to be completed. In order to obtain economically important results, a comprehensive study of the food in different stages in the life history, of the economically important food fishes of U. P., is essential.

11. *Research Worker*—Dr. Dharam Narain, Zoology Department, University of Allahabad.

Research Project—The Gametogenesis of fishes.
Papers published:

(1) Studies in the gametogenesis of fishes—The yolk nucleus of Balbiani. *Proc. Nat. Acad. Sci*, India. Vol. 21, Part. II, 1951.

(2) Studies in the gametogenesis of fishes. The role of nucleoli in oogenesis (In Press) *Proc. Nat. Acad. Sci.* India.

(3) Studies in the gametogenesis of fishes—Infiltration of the cytoplasmic organelles from the folliole cells into the oocytes. *Trans. American Microscopical Soc.* Ohio, U. S. S.

Studies on the germ cells (both male and female) of certain fishes have been carried out specially with reference to cytoplasmic organelles viz. the mitochondria and the golgi bodies. The occurrence and the fate of the yolk nucleus of Balbiani has been noted in the oocytes. The phenomenon of the nucleolar extrusions from the nucleus into the cytoplasm has been observed. It has been shown that the golgi bodies infiltrate from the follicular cells into the oocytes. The problem is vast and it is proposed to continue the studies so far as possible.

12. *Research Worker*—Dr. H S. Chaudhry, Professor of Zoology, D. S. B. College, Naini Tal.

Research Project—Morphology and biology of certain food fishes.

The studies on the morphology and biology of Barbus and other food fishes of Kumaun lakes has been initiated. A preliminary survey of the Naini Tal and Bnim Tal lakes was undertaken. A few observations about the feeding habits of fingerlings of Barbus have been made under the laboratory conditions. The morphological study of Barbus and another important food fish, the Mirror Carp, is in progress.

GEOLOGY

1. *Research Worker*—Sri B. S. Tewari, Geology Department, University of Lucknow, Lucknow.

Research Project—The genus Spiroclypeus from Kutch, Western India.

Paper Published—A paper on this subject has been published in *Current Science*, 1956, Vol. 55, page 319.

Many specimens of *Spriociypeus ranjanae* spnov were isolated from a compact yellowish white limestone outcropping at a distance of about 2 furlongs north-east of a village Waior. The author has described these species. The author's identification has been confirmed by Dr. M. F. Glaessner of the University of Adelaide, Australia.

2. *Research Workers*—Dr. D. K. Chakravarti, and Sri V. B. Godse, Department of Geology, Banaras Hindu University, Varanasi.

Research Project—Field observations of the area between Gudma and Salekasa.

The area surveyed is approx. 100 sq. miles, with a length of 20 miles, along the railway line and about 5 miles in width ($2\frac{1}{2}$ miles on either side of the railway line).

Various types of rocks, from acidic to basic in nature, are found, to occur. Some of the important rock types as have been recognised in the field include, coarse-grained granite, fine-grained granite, actionolite schist, hornblende schist, amphibolite, gabbroic rock, dolerite, porcellanite, porphyries and iron ore. With Amgaon as base camp the area all around it was surveyed.

1) Only three major types of rocks, viz. micro-granite or felsite, basic rock and the coarse-grained granite, are recognisable around Amgaon.

(2) The probable stratigraphic sequence of the rocks appear to be as follows. The white to dark gray-coloured micro-granite or felsitic rock, which happens to be the country rock, was intruded at a later stage by the dark green basic rock and finally by a coarse-grained white to pink-coloured granite.

(3) The coarse-grained granite makes the bulk of the area and forms most of the prominent hills around Amgaon.

(4) The assimilation of the country rock and the previously intruded basic rock by the coarse-grained granite has resulted in certain textural and mineralogical variations which have offered interesting features for further study.

(5) Due to this assimilation, xenoliths of dark green basic (fine to medium-grained or even coarse-grained texture) are seen in the coarse-grained granite, which range in size from that of pea to even 2 ft. square in dimension and in all sorts of shapes. Due to the intermixing of these two, a series of intermediate rocks are produced.

3. *Research Workers*—Dr. D. K. Chakravarti, and Sri V. B. Godse, Banaras Hindu University, Varanasi.

Research Project—Investigation of the granitic intrusions of U. P. adjoining states with special reference to the metalliferous veins and deposits associated with them.

The area was geologically surveyed and mapped on a scale of 4" i. e. 1 mile under the field guidance of Dr. R. S. Mithal. The major country rocks are granites and gneisses; other rock types include feldspathic schist, dolerite dyke, hornblende-schist, actionolite schist, garnetiferous amphiolite schist, and porcellanites and rhyolitic tuffs. Iron ore deposits form the major economic mineral in the area. It is being worked by two concerns. A preliminary study of the iron ore has been done and the results in the form of a paper were sent as mentioned in column (4). At present the chemical analysis of the ore in progress.

The chemical tests indicated the presence of titanium and vanadium. Further study of the polished sections, differential thermal analysis and X-ray study of the ore is planned to assess correctly the form in which these elements occur. It might prove to be a good workable ore (vanadium and titanium for special types of alloys. India urgently requires these minerals for the development of her expanding steel industry. So the present phase of the work is to prove it as an ore of vanadium and titanium. Secondly its nature of occurrence and geological relation with associated rocks have to be studied with a view to exploring other deposits of similar nature.

4. *Research Worker*—Dr. P. N. Ganju, Department of Geology, Muslim University, Aligarh.

2. *Research Project*—Petrological studies of Indian coals.

A comprehensive study of the petrological constituents of coals from some Jammu coalfields has been completed. The microscopic examination was made on thin sections and polished blocks of coal. As a result of this study it has been found that the Jangalgali coals are composed almost entirely of woody tissues which do not show any well preserved plant structures. Fungal organisms have produced a widespread decay in these tissues, Sclerotia resembling *Sclerotites brandonianus* occur in large numbers. Teleutospores occur in various forms. Siderite matter is quite abundant. The Kalakot coals appear distinctly clarainy showing thin strips of vitrain in a ground mass which is largely composed of finely disseminated fusain material. Balls of fusain are conspicuous. Mineral matter comprising largely of siderite and ankerite is widely distributed in the ground mass. Fungal spores are less abundant.

The microscopic constituents reveal that the coals have generally undergone much compression and folding, the Jangalgali coals more so than those of Kalakot. In the nature of their fungal organisms these coals appear to resemble some tertiary coals of Assam.

MEDICINE

1. *Research Workers*—Dr. S. S. Misra, Dr. G. P. Elhence and Dr. N. N. Wig, Medical College, Lucknow.

Research Project—Pulmonary function tests in health and diseases.

Pulmonary function tests were performed in a large number of normal healthy young adult males (mostly medical students and members of housestaff) and some normal healthy young adult females. The results are tabulated below :

No.	Pulmonary function tests	Males (75 cases)		Females (50 case)	
		Average	Range	Average	Range
1(a)	Vital Capacity ..	3320 c.c. ..	3975-2700 c.c.	2148 c.c. ..	3000-1600 c.c.
1(b)	Vital Capacity/S. A.	1988 c. c. ..	2433 c.c. ..	1484 c.c. ..	2000-1126 c.c.
2	Residual vol. ..	1538 c. c. ..	2180-1340 c.c.	2111 c c. ..	2890-1700 c.c
3	Total Lung Vol...	4958 c. c. ..	5530-4680 c.c.	4259 c.c, ..	4740-3920 c.c.
4	Res. Vol. X 00/ Total L. Vol.	33 per cent.	26·7 38·4 per cent.	49·5 per cent	36·9-54·3 per cent.
5	M. B. C. in litres/ Mt.	118·6 L. ..	164-80 L. ..	71·8 L, ..	98·0-52 L.
6	Mt. Ventilation ..	8·9 L. ..	10·4 7·2 L.	7·9 L, ..	9·8-5-8 L.
7	Breathing Res. ..	92·5 per cent.	83·9 94·5 per cent.	89·9 per cent	35·9-92·7 per cent,
8	Chest Expansion..	6·3 cm. ..	8·9-8· c, m.	4·3 c.m, ..	6·6-2·5 c.m.
9	Diaph. Excu. Right dome	5·9 cm. ..	7·9-4·8 c.m.	5·2 c.m. ..	6·3-4·3 c.m.
	Diaph. Excu. Left dome	6· cm. ..	8·0-4·6 c.m.	5·3 c.m. ..	6·4-4·5 cm.

Abreviations—

1. Vital. Cap./S. A. = Vital capactiy per square metre surface area.
2. M. B. C. = Maximum breathing capacity.
3. Mt. Ventilation = Minute ventilation.
4. Breathing Res = Breathing reserve.
5. Diaph. Excu. = Diaphragmatic excursion.

The workers have also given references to citations of other workers engaged on similar work.

Determination of pulmonary function tests is of paramount importance in assessing the degree of damage to the lungs from functional nd-point, in various pulmonary diseases as well as the degree of vement or otherwise as the cases are followed up This is of importance in the field of thoracic surgery. When irreversurgical procedure are contemplated for diseases affecting nerative that only those cases are selected for operaurgeon can be fairly sure that they would not get ative dyspnoea. Assessement of respiratory urate prediction as to which patients are d. For this evaluation, it is necessary the various pulmonary function are known. Review of British andard average values for here are too high for the Vital capacity in normal m 4406 c. c. to 3320 c.c. 2711 c. c to 4651 c. c. and the corresponding Indian figure is Again, these values vary from region to region in this vast Indian sub-continent Therefore, it is essential to find out the average normal values in different age groups and both sexes in the different regions of India.

In the second report the authors performed pulmonary function tests in 130 cases under the following heads :

1. Pulmonary emphysema.
2. Tropical pulmonary eosinophilia.
3. Pleural effusion.
4. Chronic lung abscess.
5. Bronchiectasis.
6. Bronchiectasis with compensatory emphysema.
7. Bronchial asthma.
8. Lobar pneumonia.

In this very report they have further covered 95 cases.

It has been observed that various pulmonary diseases present a more or less definite pattern of changes in the different pulmonary function tests. These are as follows :

1. *Emphysema Cases*—(*a*) Maximum breathing capacity is reduced to a much greater extent than the Vital capacity, e. g. if in a particular case vital capacity is 4 per cent of normal, then the maximum breathing capacity will be only about 15—20 per cent of normal.

(*b*) Total lung volume is normal or slightly higher than normal.

(*c*) Residual lung volume is greatly increased.

2. *Tropical Pul. Eosinophilia*—(a) Vital capacity and maximum breathing capacity are reduced, more or less, to the same extent.

(b) Total lung volume is nearly normal.

3. *Pleural Effusion*—(a) Vital capacity is reduced to a greater extent than the maximum breathing capacity. e. g., if in a particular case maximum breathing capacity is 50 per cent of normal than the vital capacity will be only about 30 per cent of normal.

(b) Total lung volume is diminished, its degree depending upon the size of effusion.

(c) The diaphragmatic dome on the side of effusion shows restricted respiratory excursions.

4. *Chronic lung abscess*—(a) Vital capacity and maximum breathing capacity are reduced, more or less, to the same extent.

(b) Total Lung Volume is slightly diminished.

5. *Bronchiectasis*—The pattern of changes in the pulmonary function test is same as in chronic lung abscess.

6. *Bropshiectasis with Compensatory Emphysema*—The pattern of changes in pulmonary function tests is same as in emphysema cases except that here, the total lung volume is diminished.

7. *Bronchial Asthma*—The pattern of changes in pulmonary function tests is same as in emphysema cases.

8. *Lobar Pneumonia*—The pattern of changes in pulmonary function tests is same as in pleural effusion cases.

The research assistant Dr. Ehsnce received his M. D degree from the University of Lucknow on this work.

This work was further pursued and the observations are summarised below :

1. *Emphysema Cases*—(a) Vital capacity and maximum breathing capacity, both are decreased while residual lung volume is greatly increased.

(b) The decrease in maximum breathing capacity is proportionately much more than vital capacity.

2. *Broncheal Asthma and Bronchiectasis with Compensatory Emphysema*—Changes are similar to pulmonary emphysema.

3. *Tropical Pulmonary Eosinophilia*—Vital capacity and maximum breathing capacity are reduced, more or less, to same extent.

4. *Pleural Effusion*—(a) Vital capacity is reduced to a greater extent than the maximum breathing capacity, e. g., if in a particular case maximum breathing capacity is 50 per cent of normal then the vital capacity will be about 30 per cent of normal.

(b) Total lung volume is diminished, its degree depending upon the size of effusion.

(c) The diaphragmatic dome on the side of effusion shows restricted respiratory excursions.

5. *Lobar Pneumonia*—The pattern of changes in pulmonary function tests is same as in pleural effusion cases.

6. *Chronic lung Abscess and Bronchiectasis*—(*a*) No specific pattern except vital capacity and maximum breathing capacity are reduced, more or less, to the same extent.

(*b*) Total lung volumes is lightly diminished.

It is hoped that estimation of pulmonary function tests may be of some value in the diagnosis of the underlying pulmonary disease specially in pulmonary Emphycema which is notorious for its very fallible physical and radiological signs.

2. *Research Workers*—Dr. B. B. Bhatia and Dr. Asim Kumar Dutt, Medical College, Lucknow.

Research Project—Etiology of serious pleural effusion.

During this period (May 1, 1954 to October 31, 1954) of the research works, 21 cases of pleural effusion were admitted in the medical wards All the cases were investigated and the result of which is tabulated below. Out of these 21 cases, 18 were cases of idiopathic pleural effusion, one was a case of spontaneous pneumothorax with fluid in pleural cavity and 2 cases were of Empyema.

The necessary investigations in the blood and pleural fluid were done. The chest was screened or X-rayed in all the cases and out of 21 cases, 2 cases had tubercular lesion in the lung. Sputum of the patient was repeatedly examined for A. F. B. and out of the total figure, 2 cases were positive or A. F. B. In the blood examination total and differential W. B. C. count and erythrocyte sedimentation rate were done, the finding of which is tabulated in the following chart. The pleural fluid was examined physically for colour, reaction, Sp. gravity and the Rivalta test was performed to find out the exudative or transudative nature of the fluid, chemically proteins, sugar and chlorides were estimated, and microscopical examination for the total and differential cells in the fluid and smear for acid fast bacilli were done. During these 6 months of the research work much stress was laid on the smear examination of the pleural fluid for acid fast bacilli to find out the tubercular aetiology of the effusion.

In the second report twenty cases of pleural effusion were admitted, in the hospital and the results of investigations have been reported. The work shows that by careful examination of the smear of the pleural fluid, tubrcle bacilli can be demonstrated in fair number of cases. The results of the culture of the pleural fluid for acid fast bacilli does not give encouraging result, the cause for which is not clear.

3. *Research Workers*—Dr. T. N. Chawla, and Dr. P. S. Bhargava, Dental College and Hospital, K. G. Medical College, University of Lucknow.

Research Project— Incidence of dental caries and gingival status of Lucknow school going children.

The following plan of procedure was adopted :

A. (i) The subjects shall be the school children of age groups reading in the first to tenth school classes.

(ii) It was decided to choose the schools from the various different mohallas of Lucknow so that the specimen selected should represent Lucknow as truly as possible.

(iii) Because of obvious difficulty that arose because of intermingling of children of various social strata in many of the schools the previous plan of catagorising children into various social strata was discontinued. It was also not possible to probe into the confidential registers of the school to make a detailed study of income group of parents of the children.

B. Chart for recording the clinical findings was designed and the methods of examination finalized.

(i) The general health of the children was to be graded by the age, height-weight-ratio and the general physical built up of a child.

(ii) The extraneous stains on teeth were divided into orange, brown and black colours and graded into four degrees depending upon the severity. This division into different grades was arbitrary and a large number of children were examined jointly by all three of us to remove the personal error.

(iii) Similarly the degrees of materia alba, calculus and severity of gingivitis were graded. A normal gum was taken to be a pointed gingiva with pale pink colour, of firm consistency and stippled texture.

(iv) In calculation the total overall severity of gingivitis and calculus as recorded in various sections of arches was added up.

C. The age of the children was to be noted from the school register, and in the subjects where it was not available the age was calculated by taking into consideration all the following factors :

(i) Direct questioning of the child regarding the age.

(ii) The grade in which the child was studying.

(iii) The number of failure in school, if any.

(iv) Intelligence of the child and general physical growth of the child.

D. The armamentarium consisted of mirror, sharp, explorer blunt probe weighing machine, millimeter tape.

E. Examination was conducted in shade and in broad day light.

F. Details of procedure of examination and signs were standardized.

About 3,000 students (about 800 girls and 2,200 boys) from different educational institutions of Lucknow were examined.

The results on caries pattern are as follows :

	Boys	Girls
Total number of children examined ...	2,194	814
Children that were caries free	1,227	460
Children that had one or more carious teeth ...	967	354
Percentage of children having caries ...	44·9%	42·9%
Total number of deciduous teeth examined ...	13,926	7,202
Number of carious deciduous teeth ...	1,677	711
Teeth that had fillings	22	18
Percentage of treated deciduous teeth ...	1·3%	2·5%
Total number of permanent teeth examined ...	42,192	12,402
Number of permanent teeth that were carious	867	268
Filled teeth	19	...
Percentage of treated teeth	2·19%	0%

The above analysis reveals the apathic lack of dental attention paid to our school going population.

4. *Research Workers*—Dr. S. S. Misra and Dr. K. M. Saxena, Medical College, Lucknow.

Research Project—Investigations of tuberculous meningitis with special references to detection of tubercle bacilli in the cerebro-spinal fluid.

The investigators have examined about 26 cases of tuberculous meningitis admitted in the medical wards. The important findings are described below :

(1) The characteristic physical and chemical changes in the C. S. F. were found in all the cases at some time of the disease.

(2) Lavinson's test was found to be positive (+ to + + +) in 18 (70%) cases.

3. Mantoux Test varied from negative to strongly positive and was positive in 16 (63%) cases.

4. X-Ray Chest revealed evidence of lung involvement probably of tubercular origin in 13 (50%) cases.

5. Sputum was positive for tubercle bacilli in one case only.

6. Acid Fast Bacilli were demonstrated in 6 cases (23%) in the C. S. F. The smear examination showed A. F. B- in 3 cases. Culture examination of the C. S. F. on Lowensteins medium demonstrated tubercle bacilli in 4 cases.

During this period of 6 months search for tubercle bacilli was made by smear and culture examination of the C. S. F.

PSYCHOLOGY

Research Workers—Prof. Kali Prasad and Sri Kailash Chandra Khemka, Department of Psychology, Lucknow University, Lucknow.

Research Project—Attitudes of values of students of twelve Indian Universities (experimental Social Psychology).

The investigation covered the following major areas of attitudes and values:

(i) Communication

(ii) Health and personal adjustment.

(iii) Values of college education.

(iv) Vocational attitudes and values.

(v) Social and religious attitudes.

(vi) Attitudes towards political issue, government and world affairs.

(vii) Miscellaneous topics: e. g., attitudes towards racial religious, caste and educational groups; war and peace inter-personal relations in the context of the family, etc.

These attitudes and values were studies in relation to the following major personal variables.

Field of study; University classs; academic level of attainment mother tongue; age; sex; religion; caste; parental and sibling data marital status; population size of the home town or village; residentia status during college year; socio-economic status; and extra curricular activities.

An analysis of the Questionnaire data obtained from 2,047 students from the Univesities of Aligarh, Banaras, Bombay, Calcutta, Delhi Lucknow Madras, Nagpur, Osmania, Tranvancore and Indore is being progressively carried out. So far, the following sections of the Questionnaire have been analysed in detail:

(a) Vocational attitudes (in part)

(b) Social and religious attitudes-values.

(c) Attitudes regarding government, politics and world affairs.

(d) Certain portions of the section dealing with miscellaneous topics.

PSUP—3 UGC—1957—600—(P.D.)